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CONTENTS

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BOOK REVIEW

Handbooks for the Identification of British Insects, Vol. 1, Pt. 16, SIPHONAPTERA, 1957 (Royal Entomological Society of London), pp. 94, 200 line illustrations. Price £1. The recorded distribution and hosts of Siphonaptera in Britain. *Ent. Gaz.*, **8**:45-75, 1957. Price 6s. Both by F. G. A. M. Smit.

In reviewing these two works my only regret is that they are not included under one cover. The second is so essentially a continuation of the first that they should never have been separated. Together, as first written, they adequately demonstrate the extreme thoroughness by which this author's works are characterized.

In the 'Handbook' 56 sps. and ssps. of fleas are recorded from the British Isles, but five more forms (hybrids or intermediates) are given in the 'Distribution List'. The 'Handbook' gives detailed collecting instructions, but whereas Smit recommends using cloth bags for receiving hosts' bodies, I prefer old envelopes, which can be destroyed after one use, thus preventing contamination of gatherings. The value of nests (which can hold thousands of fleas) is rightly mentioned, but I would suggest in addition the gathering of soil from immediately below underground nests, for it often contains many

pupae. Full instructions are given for preserving, labelling and mounting specimens.

A very adequate glossary follows which, for beginners, will remove the terrors of the terminology of the Keys. These I have found from experience with early draft versions and tests of the published version to be easy, accurate and clear. They are made perfect by the excellent diagrams, many drawn especially for the 'Handbook', mostly arranged by the author to be with the related text and illustrating every form listed. At the final clue for each flea is given a brief summary of its host preferences and distribution, and that of other subspecies where applicable.

Then comes an ecological classification of our flea fauna based on the domiciliary habits of the hosts and a list detailing the hosts from which each flea has been taken in each of England, Scotland, Ireland and Wales. I do not feel that this serves any very useful purpose except in the absence of the second paper.

The only misprints I have noticed are '*agyrtesnobilis*', p. 39, clue 2, line 5, and the omission of three of the author's initials on the back cover.

The 'Distribution and Host List' is another most valuable effort giving all the hosts and counties from which each flea has been recorded according to the 293 items of the numbered bibliography which have been examined by the author up to 1st June, 1956. Very few items have been missed. Many of the county records are published for the first time and come from the author's own observations. The remainder are tied to the bibliography by the reference numbers. An analysis of this paper, which should be in the library of every local natural history society, shows, *inter alia*, that Hertfordshire with 42 forms is the best collected county in England, whilst Lincs. and Worcs. are apparently flealess! So is one county in Wales (Anglesey), four in Scotland (Banff, Bute, Kirkcudbright and Selkirk), and seven in Ireland (Antrim, Carlow, Kildare, Leitrim, Tipperary, Waterford and Westmeath).

The host list is made very complete by the inclusion of the casual and accidental hosts as well as the normal hosts. Particularly interesting is the number of records from the Yellow-Necked Field Mouse (*Apodemus flavicollis*), for which there were no earlier records.

A few important misprints occur—in item 52 insert the date 1893; item 84, for 106 read 206; item 171, for 179 read 197; in items 183 and 184, insert date 1897; item 220, read **2**.

The 'Distribution List' demonstrates the great paucity of locality records— the 'Handbook' provides the means by which this can be remedied. Apart from the entomological public to which they will appeal these publications should be owned by every serious mammalogist and ornithologist who desires to know a little more of his study than mere spotting.

R.S.G.

OBSERVATIONS ON *HYDROPORUS FERRUGINEUS* STEPH. (COL. DYTISCIDAE), AND SOME FURTHER EVIDENCE INDICATING INCAPACITY FOR FLIGHT

By DOROTHY J. JACKSON, F.R.E.S., F.L.S.

Hydroporus ferrugineus Steph. is a very local species usually found in springs. In a recent paper (Jackson, 1956) I described the flight reduction exhibited by four specimens taken in Scotland (three from Elgin and one from Berwickshire) and I compared the wings, metatergum and muscle discs of this species with those of *Hydroporus planus* (F.), which is a good flyer. Since then, thanks to the kindness of the late Mr. Philip Harwood, I have been able to examine further specimens. In 1956 Mr. Harwood referred to the occurrence of this species in a winterbourne near Cranborne, Dorset. He most kindly sent me several set specimens he had collected there and also one taken near Aviemore. In April, 1956, he helped me to collect further specimens in the locality near Cranborne. I brought these beetles alive to St. Andrews and this enabled me to make observations on their habits and to carry out further dissections.

Anatomical Observations

Examination of the Aviemore specimen and of those from Dorset confirmed my previous observations. In none of the specimens examined were the wings of full size (as compared with a flying *Hydroporus* of similar size) and the metatergum was short and not strongly sclerotic as in flying *Hydroporus*, and the discs of the pleural flight muscles were small. In the freshly killed specimens from Dorset I found that the area in the metatergum occupied in flying species by the flight muscles was filled up with fat body. The muscles of the hind legs (the extensor and flexor trochanter muscles) were less well developed than in *H. planus* and the furca was smaller and less sclerotic. This will be correlated with the more sluggish habits of the beetle, for, as will be mentioned later, *ferrugineus* is a poor swimmer.

Figures have been given (Jackson, 1956, Figs. 3 and 4) showing the differences in the wings and metatergum between *H. ferrugineus* and *H. planus*. These striking differences are evident, without dissection, by removing the elytra. In *planus* the wings are so large and voluminous and so densely folded that they hide most of the abdominal tergites, but in *ferrugineus* the wings are much smaller and little folded, so that all the abdominal tergites can be seen distinctly through them. The difference in length of the metatergum between the two species is most noticeable. In *planus* the metatergum, measured at the sides in a whole specimen, has a greater length than the

pronotum measured directly in front of it, while in *ferrugineus* the length of the metatergum at this point is less than the length of the pronotum. In *planus* the metatergum and also the abdominal tergites are deeply sclerotic, but in *ferrugineus* the metatergum is paler and the abdominal tergites, excepting the propygidium and the pygidium, are very pale. All these characters can be recognized in *ferrugineus* without even removing the elytra if the beetle is examined in water or alcohol, for the elytra are semitransparent. It would be of interest if those collecting this species would examine the beetles when wet to ascertain the size of the metatergum and the wings since this can be done without damage to the specimen. There can be no doubt that the much greater development of the metatergum in *planus* is correlated with the presence of fully developed flight muscles, while the reduction of the metatergum in *ferrugineus* is one of the changes in structure involved in reduction of the flying apparatus.

Habitats

Rüschkamp (1926) and Thienemann (1950) record this species as occurring over the mountainous districts of central Europe. Horion (1941) records it from spring pools and mountain streams; and even in underground waters as in wells and mines. Heberdey (1931) states that he took this species in small pools with stony bottoms, thickly filled with fallen leaves, near Graz and around Göttingen. In Britain, Professor Balfour-Browne (1940) cites various localities, including (1953) Mull and St. Kilda. Mr. J. Balfour-Browne informs me that he took the species abundantly in mountain springs in North Wales during April, May and June and less commonly in September. He states that they occurred in extremely small springs in a stony hillside from which burns arise. Dr. Richter, who sent me specimens from Elgin, obtained them from a trickle on the banks of a burn. I took a single specimen in Berwickshire in June, 1951, in a trickle from a spring in a field. Near Cranborne the species occurred in shallow pools in a winterbourne. The pools had a firm bottom covered with flints and with the moss, *Fontinalis antipyretica* Hedw., growing profusely amongst them. Just above these pools the valley was dry. The pools were slowly flowing, being fed by springs, and every now and then one saw water bubbling up. The beetles were obtained by shoving a net under the stones and moss and spreading the contents on a ground sheet. Mr. Harwood told me that the species was already established in this winterbourne in 1933 (recorded by Donisthorpe, 1936) and that some years ago the stream was completely dry during two consecutive winters.

Habits

I tested the beetles for flight at St. Andrews but not one attempted to fly. In the testing dish I used, a tin lined with cardboard, the beetles ran about actively. In trying to climb up the slippery sides they fell upon their backs and had difficulty in getting on their feet again, but they never opened their elytra to help them to right themselves as

flying species frequently do. It was noticed that *ferrugineus* is a much less active insect in the water than is *planus* and comes up much less frequently to take in air. I placed six specimens of each species in a jar with three inches of water, and a little moss in the foot of the jar but not reaching to the surface. The two jars were placed side by side at a temperature of 62 deg. F. While *planus* swam about actively, coming often to the surface to take in air, *ferrugineus* was very sluggish, clinging to the moss or slowly swimming at the bottom of the jar. Only rarely, by comparison with *planus*, did one come up to renew its air supply, crawling slowly and laboriously up the side of the jar and not swimming directly to the surface as *planus* does. Some *ferrugineus* started their upward climb on the moss as far as it reached and then swam to the side of the jar and continued up it. Arrived by this means at the surface film and while still clinging to the glass, the beetle turned round and pushed the apex of the abdomen into the air, then quickly swam down to the bottom. During one hour six *planus* made seventy-eight journeys to the surface to take in air, but the six *ferrugineus* only made eight. Each specimen of *planus* would thus average thirteen respirations in the hour, but *ferrugineus* only 1.3. The time spent at the surface was not appreciably different in the two species. Sharp (1878), who timed the respirations of some Dytiscidae, found that *Hyphydrus ovatus* (L.) could remain one hour 'without breathing', but *Agabus bipustulatus* L. rose on an average about once in thirteen and a half minutes. Since *ferrugineus* is not active in the water it will expend less energy and require less oxygen, and as, under natural conditions, it occurs in shallow water it will probably reach the surface by creeping up moss and other plants.

I intended to repeat the above observations, but four days later I was much surprised to find four of the *ferrugineus* were dead and all with fungus sprouting from them. I sent one to Mrs. Balfour-Browne, who has kindly identified the fungus as *Saprolegnia ferax* (Grinth) Thur. She tells me it is a common fungus on frogs, fish, insects, etc., in water and that it generally attacks only damaged and decayed tissue. I had provided the beetles with *Chironomus* larvae to eat, but possibly the beetles were not sufficiently agile to kill the larvae. These beetles died after only thirteen days in captivity, but other Dytiscidae of various genera which I have kept for observation have lived for months on such a diet. Their early death must be unusual, as Mr. Balfour-Browne states that he has had adults remaining alive for about fourteen months.

It would be most interesting to know how *ferrugineus* passes the summer when the winterbournes dry up, and how it survived two consecutive winters when there was no water in the Cranborne stream. The evidence I have so far obtained from dissection of specimens from four localities (extending from Elgin to Dorset) points to the species being incapable of flight, so that dispersal by flight to other

waters appears to be unlikely. Since the beetles are known to occur in underground waters they may follow the retreating water as Professor Balfour-Browne (1940) suggests. Mr. J. Balfour-Browne, whom I have consulted, has interesting evidence bearing on this problem. He states that the larvae, which he has bred in tumbler aquaria with the greatest of ease, are of a 'subterranean' type, being much paler than any species of the genus known to him. He has no hesitation in stating that the larvae live normally in subterranean waters and that, when the mountain springs dry up in summer, the adults follow the receding water underground and aestivate almost certainly in the damp earth of the 'dry' spring head. Adults emerging from the pupal skin, he considers, would also lie quietly until moisture returns. The occurrence of the beetles in such very small springs—he describes them as 'of the size of a small teacup'—on the hillsides in Caernarvonshire, virtually demands, in his opinion, a subterranean habitat for the beetles. He obtained the eggs of this species only in May and June and the eggs hatched in from seven to ten days.

Dispersal

The local distribution of *ferrugineus* and its apparent inability to fly suggests that it is incapable of active dispersal such as Professor Balfour-Browne inferred (1953). Restricted as it is to a particular habitat which may rarely be examined by collectors, Mr. Balfour-Browne suggests that the species may not be as rare and local as is usually considered. Drainage and cultivation will have destroyed many of its haunts, but it will persist in uncultivated mountain regions where its habitats are undisturbed. Occasional specimens found in bog pools may have been washed down from springs in flood water, and it may be able to spread in underground waters (Jackson, 1956, p. 96).

Antennal Abnormality

A single specimen of *H. ferrugineus* which Mr. Harwood kindly gave me (collected in the Cranborne winterbourne on 10.4.36) has a remarkable malformation of one antenna combined with a reduction in the number of joints to nine, Fig. 2. The left antenna was normal, with eleven joints, Fig 1. I have recorded variation in the number of joints in the antennae in *Hydroporus discretus* Fairm. (Jackson, 1954), but no bifurcation such as occurs in this specimen

ACKNOWLEDGMENTS

I am much indebted to the late Mr. Harwood for so kindly showing me the Dorset locality for *H. ferrugineus* and for so generously providing me with specimens, and I am most grateful to Mr. Balfour-Browne for allowing me to quote from his valuable observations on this species, which have added greatly to the interest of this paper.

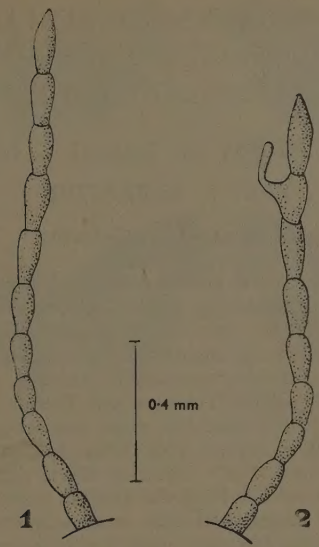

Fig. 1. Left antenna of *Hydroporus ferrugineus* Steph., seen from above, with normal number of joints.
Fig. 2. Right antenna of same insect.

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PAMMENE AURANTIANA (STAUDINGER), A TORTRICID RECENTLY DISCOVERED IN THE BRITISH ISLES (LEP: TORTRICIDAE)

By J. D. BRADLEY AND BRIAN O. C. GARDINER

PART I. NARRATIVE

By BRIAN O. C. GARDINER

It was in 1943 that after having collected 'Macros' for nearly ten years, I first took up collecting 'Micros', and a considerable number were amassed during my first two years collecting. Unfortunately, the lack of a good book on identification and the lack of any expert advice led to the majority remaining unnamed, and my interest waned. Consequently all the Tortrices and Tineids collected in 1943 and 1944 were placed in a store-box where they languished until 1957.

The final breaking of old ties with Dover, Kent, led to the decision to compile an account of my collecting there, and, in view of the absence of any 'Micro' list from the area, it was considered worthwhile to get them named and they were submitted to Mr. J. D. Bradley at the British Museum, who spotted amongst them a pair of *P. aurantiana*. By a coincidence two unknown Tortrices, caught by Mr. L. Price in 1956, were also submitted to Mr. Bradley at about the same time and these too proved to be *aurantiana*. An account of the capture of these, and mentioning my own two, is reported by Mr. S. Wakely in *Ent. Rec.* (1957).

My own two specimens, a pair in good condition, were taken on 11th July, 1943, and my diary entry for that day is as follows: 'Dover. Thick cloud all day, no sun, strong wind, occasional spots of fine rain, warm. Beat the whole of garden (The Red House, River-in-Dover, Kent) which is thickly overgrown with weeds. Took: 3 Noctuids, 29 Geometrids, 11 Pterophorids, 17 Pyrales, 53 Micros.' (Inc., Pyrales (i.e. Phycitids and Scoparia) Tineids and Tortricids.)

The two *aurantiana* were amongst the 53 Micros and, being a pair and mounted together on the same strip of polyporous with one label, were possibly taken *in cop.*, though I have no certain proof of this.

It is also unfortunately impossible to say what the *aurantiana* were beaten out of. The garden mentioned was a wooded area of two and a quarter acres, some two miles inland, and contained much privet and ivy which was beaten regularly, besides many other trees, not to mention the weeds. A fuller description is being published in a later issue of the *Gazette* in connection with a full list of Dover Lepidoptera. In 1955 the garden was cleared and many of the trees cut down.

Figs. 1 and 2. *Pammene aurantiana* (Stdgr.), ♂ and ♀, respectively.
Fig. 3. *Pammene regiana* (Zeller).
Fig 4. *Dichrorampha flavidorsana* Knaggs.

METRIOPTERA BRACHYPTERA (L.)
Fig. 5. ♂ f.*marginata* (Thunb.). Fig. 6. ♀ normal brachypterous form.

Little appears to be known about *aurantiana*. It is chiefly a Central European species, being found in Germany, Austria, Hungary, and also in Holland (Staudinger and Rebel, 1901). It is also recorded locally from Denmark (Van Deurs, 1956) and France and Belgium (Lhomme, 1946). The larva is stated probably to live on maple (Eckstein, 1933, Lhomme, 1946, and Van Deura, 1956), and on the Continent the moth is usually on the wing during July and August.

PART II. DESCRIPTION

By J. D. BRADLEY
British Museum (Natural History)

The following description is based upon the male and female specimens collected by Mr. Brian Gardiner at Dover, the male specimen collected at Studland, in Dorset, by Mr. L. Price, and Continental examples in the British Museum collections. The Dover and Studland specimens have been generously donated to the British Museum (Natural History) by their collectors.

The type specimen of *Pammene aurantiana* (Stdgr.) is in the Zoologisches Museum der Humboldt Universität, Berlin; and through the helpful co-operation of Dr. H. J. Hannemann of that institution it has been possible to verify the identity of the British specimens by comparing them with the type.

Pammene aurantiana (Staudinger)

Phthoroblastis ? *aurantiana* Staudinger, 1871, Berl. ent. Z., **14**: 286. Plate 4, Figs. 1 and 2. ♂ ♀ 14-15 mm. Labial palpus cream-buff, terminal segment overlaid with fuscous. Head greyish cream-buff. Thorax and tegula greyish ochreous with a weak ferruginous admixture. Antenna and scape fuscous, edged with whitish anteriorly. Fore wing: general appearance shining golden reddish brown: basal area overlaid with greyish and blending in coloration with thorax and tegula, a broad oblique rather diffuse ochreous-orange median dorsal blotch reaching nearly to middle of wing; this blotch is somewhat effaced outwardly and in general is not very conspicuous in comparison with the ground colour; a weak admixture of dark brown along dorsal margin basad of blotch; terminal margin and tornal area suffused with a strong admixture of dark brown, three or four minute black dashes arranged one above the other at about middle of inner edge of terminal margin, a thin leaden metallic line from costa at about 2/3 curving outwards and reaching nearly to tornus, a second similar line from costa at about 5/6 curved more boldly outwards but shorter and terminating in terminal margin a little below middle of wing, both lines are frequently interrupted; costa alternately marked with fuscous-black and whitish strigulae which are short and inconspicuous at base gradually becoming stronger and conspicuous toward apex, a small fuscous-black spot at apex; cilia dark grey, with a well-defined fuscous-black basal line extending

from apex to tornus interrupted by a small ochreous dash below apex. Hind wing dark brown; cilia whitish or light grey, with a dark brown sub-basal line. Abdomen greyish fuscous above and at sides, greyish beneath. Legs cream coloured suffused with greyish exteriorly.

In coloration and general appearance *aurantiana* has a superficial resemblance to *Dichrorampha flavidorsana* Knaggs (Plate 4, Fig. 4) and *D. gueneeana* Obraztsov (= *politana* Gn.), but is readily distinguished by the fuscous-black apical spot on the fore wing which is not evident in the *Dichrorampha species*. Among the British representatives of the genus *Pammene* Hübner, in which *aurantiana* properly belongs, its nearest relative appears to be *regiana* (Zeller) (Plate 4, Fig. 3), and although differing markedly in coloration the two species are in fact fundamentally very similar in wing pattern of the fore wing.

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A NEW RECORD OF *METRIOPTERA BRACHYPTERA* (L.) *F. MARGINATA* (THUNB.) (ORTH: TETTIGONIIDAE)

A male specimen of *Metrioptera brachyptera* (L.) f. *marginata* (Thunb.) was taken on 21st August, 1941, in the grounds of Wellington College, Berkshire. This is the first male, and the second specimen of either sex, of this form to be taken in Britain. The first was a female, taken in the vinery at Wisley, Surrey, in August, 1921 (1921 Lucas, W. J., *Entomologist,* **55**: 200-203). Several others (sex not given), occurred in July, 1950, on Bicton Common, near Otterton, S.E. Devon, and were observed or taken by students of Prof. A. L. Harvey (1953. Kevan, D. K. McE., *J. Soc. Brit. Ent.,* **4**: 120). The form *marginata* is macropterous as may be seen from the photograph on Plate 4, which also shows a typical brachypterous specimen for comparison.

This macropterous specimen has remained unidentified in my collection for fifteen years because it was put away with a large number of miscellaneous insects captured during the war, and which had to be stored away for lack of time and opportunity for identification. The identification was very kindly undertaken by Mr. A. E. Gardner, F.R.E.S.

H. D. SWAIN, F.R.E.S.

SEROLOGICAL TOOLS IN ENTOMOLOGICAL RESEARCH

By FERGUS J. O'ROURKE, M.B., M.Sc., Ph.D., M.R.I.A.
(*Department of Zoology, University College, Cork*)

INTRODUCTION

Serology may be defined as the branch of biology 'concerned with the nature and significance of proteins as revealed by their reactions with antisera produced against them' (Leone, 1953). If serum, or other protein-containing material, of a given species (= the antigen), is injected into another animal (commonly either the rabbit or the chicken) according to certain specific schedules antibodies are produced in the serum of the injected animal. Serum containing such antibodies is termed antiserum. When these antibodies react *in vitro* with the corresponding antigens they give characteristic reactions such as precipitation (precipitin tests), agglutination (agglutination tests) or the fixation of complement (C. F. tests). Reactions occur typically only with corresponding antigens; less marked reactions may be given by closely related antigens. It is always possible to distinguish homologous from heterologous reactions although sometimes special techniques are required to do so. For example, the simple Ascoli ring test does not distinguish human and gorilla blood by precipitin reactions (Gradwohl, 1953), although this can be done readily, using the Libby photronreflectometer (Boyden, Gemeroy & De Falco, 1956). This instrument measures photometrically the turbidity produced by the antigen antibody interactions over a reaction range extending from antibody to antigen excess (Libby, 1938, Boyden and De Falco, 1943).

Serological techniques have been used widely by medical research workers in the fields of haematology, bacteriology, immunology, epidemiology, medical jurisprudence, parasitology and, in recent years, in genetics and embryology. Research workers in zoology have but recently come to realize the value of such techniques. The inclusion of a section devoted to Serology and Paper Chromatography in the XIV (1953) International Congress of Zoology at Copenhagen indicates the increasing importance of this field of Zoology (Leone, 1953).

West (1950) drew attention to some of the possible uses of the precipitin test in entomological research and stimulated interest among entomologists in Canada and elsewhere. It is the purpose of this review to give a broad indication of the scope of serological techniques in entomological research, to draw attention to some of the uses to which these methods have been applied and to suggest some possible future applications.

1. *Blood Meal Studies*

In the study of haematophagous insects the value of being able to

recognize the source from which these insects derived their blood was early appreciated. The identification of the nature of bloodstains has long been a concern of forensic medicine and it is not surprising that forensic methods were applied to the determination of the source of insect blood meals.

The U.S. Public Health Service workers Bull and King (1923) were probably the first to undertake the identification of the source of the blood meals of mosquitoes. Antisera were prepared in the rabbit, using human, cat, dog, horse, cow, pig, sheep and chicken blood. The blood-engorged mosquitoes were chloroformed, transected at the junction of thorax and abdomen and the stomach placed on filter paper which was dried. The dried smears were then stored for three to four months. Fifty to one hundred specimens were tested at a time, each being extracted with saline for at least an hour before testing. Capillary tubes 100 x 2 mm. with 3 mm. depth of antiserum were usually read after 20 minutes. In the first series of twenty-seven results obtained from known feedings twenty-two were 'correct', two gave no reaction, and two were 'incorrect'. The failures were due to a non-specific anti-cat serum and the weakness of the anti-human serum. A later series gave twenty-five 'correct' out of twenty-six, the one 'incorrect' result being negative and due to weak antihuman serum. Later the same authors (King and Bull, 1923) reported important results on the feeding preferences of Louisiana Anophelines using the technique. They showed that as the Anopheline density rose the proportion feeding on man fell and that *Anopheles punctipennis* did not feed on man, whereas *A. crucians* took 4.8 per cent. of its meals from human sources. Bull and Root (1923) investigated the question of animal deviation in *A. quadrimaculatus* using the same methods.

Eligh (1952) showed that better results were obtained by squashing the blood engorged mosquito on high quality filter paper (Stanscien 333) than by dissecting out the gut as Bull and King (1923) had recommended. West and Eligh (1952) showed that precipitin reactions could be obtained from *Aedes aegypti* eight days after feeding if the mosquitoes were held at 11 deg. C., whereas reactions could be obtained only for a day or two if the mosquitoes were held at 27 deg. C. Field experiments with *A. hexodontus* in Northern Manitoba confirmed this temperature effect which had previously been remarked on by Bull and King (1923). By applying this information West and Eligh (1952) were able to determine the time taken by mosquitoes to digest their blood meal at various environmental temperatures.

In Professor Alan Boyden's laboratory at Rutgers University, New Jersey, Williams (personal communication) developed a method of determining the period that had elapsed since the blood meal was taken, by titrating with a photronreflectometer blood-smear extracts against homologous antisera prepared from twelve, twenty-four, forty-eight and seventy-two hour digests. Williams has also shown that the

amount of blood taken at a meal can be determined by comparing the titre obtained with that of a homologous serum of known blood concentration. In my own laboratory at Ottawa preliminary work with the Oudin technique (referred to below) showed that it could be adapted to the same purpose.

The blood meals of mosquitoes have been widely studied using serological techniques (e.g. Riddeal *et al.* 1947, Bates, 1949), but the method has been little used in the study of other haematophagous arthropods. Tsetse fly blood-meals have however been studied in this way. Symes and McMahon (1937) studied the blood meals of *Glossina swynnertoni* and *G. palpalis*, while Weitz and Jackson (1955) determined those of *G. morsitans* at Daga Ilai, Tanganyika, using absorbed and very highly specific antisera. The very complicated preparations described by Weitz (1952) seem scarcely justified in practice since the simpler methods appear to give virtually similar results, as for example in Lambrecht's (1956) study of the sources of *G. morsitans* meals in Ruanda, Central Africa.

2. *Predator-Prey Studies*

Brooke and Proske (1946) made the first efforts to use serological techniques in the study of predator-prey relationships. By means of precipitin tests they were able to determine the proportion of known predators that had fed on a particular mosquito species. The method was to macerate the predators in normal saline and the extract was tested against anti-mosquito sera.

These studies were further extended in Professor A. S. West's laboratory at Queen's University, Kingston, Ontario, by Hall, Downe and MacLellan, who studied *Zelus exsanguis* (Stahl), a reduvid predator of the forest tent caterpillar (*Malacosoma disstria* Hbn.). The methods of preparation of antigens and antisera used were those described by Leone (1947, 1947a). Hall *et al.* (1953) showed that titres of at least 1/5,000 (with undiluted antiserum) were required for predator-prey studies. These antisera were Seitz-filtered and stored at —25 deg. C. and were in perfect condition ten months later. The anti-Forest Tent caterpillar serum cross-reacted with extracts of smears from the Eastern Tent Caterpillar (*M. americanum* F.) but not with those from the Linden Looper (*Erannis tiliaria* Harr.). It proved difficult to produce antisera of high titre and avidity with any regularity. Indeed this is the most serious problem in all serological work. Smears made from wild caught *Z. exsanguis* reacted positively. In smears prepared from known feedings positive reactions were obtained for six or seven days at room temperature which, in the field laboratory used, differed little from outdoor temperatures. Hall *et al.* (loc. cit.) stress that considerably more developmental work remains to be done before extensive applied studies can be undertaken. Furthermore, the practicability of the method is currently limited to studies of the predators of a particular host rather than the hosts of a given predator. Studies in Nova Scotia of the predators

of the Codling Moth (*Carpocapsa pomonella* L.) were complicated by the presence of a number of species of the same family (*Tortricidae*) and of a closely allied one (*Olethreutidae*), species of which gave cross reactions. These studies show that with a high titre anti-(Codling Moth pupa) serum the simple Ascoli ring test was sensitive enough to show that predatory thrips had fed on codling moth eggs.

West and his colleagues have studied mosquito predators in the Canadian North and obtained positive reactions between anti-mosquito sera and dytiscid beetles (both larvae and adults) and one species of caddis larva. An important advance was made by Hall and West (1954) when they found that antisera of very low titre (1/100) but of high avidity would detect mosquito antigen in smears of predators. As these authors say: 'Since one of the greatest difficulties in the past has been in producing high titred anti-host insect sera this discovery has removed a major block to the extensive application of the precipitin test to predator studies.'

Further studies along these lines would appear to hold great promise both in academic and applied research fields.

3. *Physiological Studies*

It is only in the last five years that the potentialities of serological methods in the study of insect physiology have been realised, and indeed as yet little has been done in this field.

In Professor C. H. Williams' Laboratory at Harvard, Dr. W. H. Telfer has worked on metamorphosis in the silkworm *Platysamia cecropia* using the Oudin technique (Oudin, 1948) to study the antigens occurring in insect blood. The Oudin technique depends on the fact that when an antigen solution is overlayered on an agar gel containing the homologous antiserum the antigen migrates into the gel, forming a band or bands of precipitate. Normally each antigen will form a separate band. The band is initially at the interface, but it diffuses slowly into the gel. The distance (d) travelled by the band varies linearly with the square root of time (t) according to the equation

$$d = k\sqrt{t},$$

Where t is the time elapsing since overlaying of antigen on gel and k is a coefficient characteristic of the antigen involved. The value of k depends on the diffusion coefficient of the antigen, its initial concentration in the antigen solution and on the concentration of antibody in the agar gel. When physical conditions are kept constant, these relationships may be expressed by the equation

$$k = \frac{d}{\sqrt{t}} = f\,(G,\ A,\ D.)$$

Where G is the antigen concentration.
A is the antibody concentration.
D is the diffusion on coefficient of the antigen.
f is a constant.

When only a single species of antigen is present *G* is constant and *A* can be kept constant by using the same antiserum in the same concentration in the agar gel and both *d* and *t* can be measured so that *k* gives a measure of the concentration of the antigen. When several species of antigen are present, each, if present in sufficient concentration, forms its own band. Thus the number of bands indicates the minimum number of antigens present in a given solution. Telfer and Williams (1953), using cell free blood of *Platysamia cecropia* larvae, produced an anti-cecropia serum in rabbits which gave a maximum of nine bands when reacted, in Oudin tubes, with *cecropia* blood. These blood antigens were found to be protein in nature and one was identified as a carotenoid pigment. Of the six bands subjected to further study it was found that all but one occurred at all stages of metamorphosis. The sixth antigen first appears in the late fifth instar larva, persists throughout the pupal period and vanishes again during adult development. The concentration of these antigens underwent changes corresponding with the morphological stages of development. Each antigen had a characteristic pattern of concentration change. All six larval antigens increased in concentration during the last larval instar and decreased again during adult development.

In a later paper Telfer (1954) studied antigen 7, an albumen which, although undetectable in larval blood, appears in the pupal blood of *cecropia*. This antigen first appears in the blood after the larva has spun the cocoon and is present in female blood at about one thousand times the concentration found in male blood. Antigen 7 is also found in solution in the yolk of unfertilized eggs. Its concentration in the female blood falls after egg production. Ovariectomy caused the antigen concentration to rise during the period when eggs were normally produced and during which the blood concentration of antigen 7 normally fell. Ovaries transferred into the haemocoel of males produced eggs, but unless antigen 7 was present in detectable quantities in the blood of the male it was not incorporated in the egg yolk. The concentration of the antigen in the clear liquid portion of the yolk is four times higher than the maximum attained in the blood during metamorphosis and twenty times higher than that of the blood at the conclusion of egg formation. It would appear, therefore, to be transferred from the blood to yolk against a concentration gradient. *Telea polyphemus* ovaries transferred into the haemocoel of *P. cecropia* females produced eggs which contained antigen 7. It is suggested that antigen 7 is produced extra-ovarially, withdrawn from the blood and incorporated into the egg yolk.

In the same laboratory Dr. M. Ketchell (personal communication) has found that the human red cell agglutinating factor of *cecropia* blood is in fact the growth and differentiation hormone (GDH) of the insect. Hence, a simple serological titration can replace a cumbersome tissue culture assay (requiring the study of testis cell nest growth) for GDH.

Once attention has been directed to the possibility of using serological techniques in the assay of complex, organic compounds it may be possible to apply the method to a wide variety of problems in insect physiology.

4. Genetic Studies

As early as 1936 Levit *et al* reported from Moscow that the Y chromosome of *Drosophila melanogaster* Meigen could be detected serologically. Complement fixation tests after absorption were used and further results were promised. I have not been able to trace any subsequent work of this type.

5. Taxonomic Studies

The remarkable successes achieved by serological techniques in both plant (Mez 1922, Chester 1937, Johnson 1954, Baum 1954, etc.) and animal (Nuttall 1904, Boyden 1942, 1953, etc.) taxonomy have not been appreciated by entomologists who have made comparatively little use of such methods. The generally poor antigenicity of insect proteins has perhaps been in part responsible for this failure to use serological tools to solve problems of insect classification.

At the species level Brown and Heffron (1928) were probably the first to use serological techniques. They used the butterfly *Eurymus philodice* (specimens which had been papered for 18 months) as antigen and the guinea pig as antiserum producer. Simple Ascoli ring tests showed marked inter-family differences. (*Papilionidae* vs. *Nymphalidae*) and distinct inter-subfamily differences (*Papilioninae* vs. *Pierinae*) between subfamilies related to the insect used as antigen. With fresh specimens intergeneric differentiation (*Eurymus* vs. *Pieris*) could be detected in antigen dilutions of 1/10. Interspecific differentiation (*E. philodice* vs. *E. eurythene*) was not obtained using dried insects, even with dilutions of $1/10^5$ and incubation periods of up to 72 hours.

Martin and Cotner (1934) demonstrated the value of the precipitin test in determining the phylogenetic relationships within the genera and subfamilies of moths in the family *Phalaenidae*. Thus the removal of *Protagrotis niveivenosa* from the subfamily Agrotinae by Barnes and McDonnough on purely morphological grounds (later supported morphologically by Draudt) was confirmed by the precipitin test reactions. Martin and Cotner (loc. cit.) studied 14 genera and 20 species in six subfamilies of the *Phalaenidae*. In addition they tested specimens from the families *Sphingidae* and *Nymphalidae*. Their serological work appears to be the most extensive hitherto attempted on insect taxonomy.

Leone (1947) was the first to use the more refined technique of photronreflectometer measurement of precipitin reactions with insect antigens. He studied the inter-relationships of the Orthoptera and in the course of this study accumulated much information of value to the entomologist interested in using serological techniques for taxonomic studies. Further he critically examines the basis of the method.

Drosophila, as one might expect, has been studied extensively with serological techniques. Cumley and his co-workers in a series of studies have used complement fixation (C.F.), precipitin ring tests, absorptions and optimal antigen-antibody ratio reactions to study the interrelations of a series of species of *Drosophila* (Cumley 1939, 1939a, 1940, Cumley and Haberman 1938, Haberman and Cumley 1939). In all about a dozen species of the genus *Drosophila* were studied, but only four, viz. *D. caribbea*, *D. melanogaster*, *D. mulleri* and *D. virilis* were extensively studied (by means of 14 morphological and five serological characters). Two of the five serological characters were based on C.F. tests (one with saline extracts of dried flies, the other with saline extracts of ether insoluble fractions of dried flies). The remaining three serological characters were based on precipitin reactions, ring tests, optimal proportion reactions and precipitin absorptions.

Cumley concludes that the results of serological ranking are more specific than those based on morphological grounds and that 'whereas on the basis of morphology, species cannot always be ranked to the third and fourth places, but with serological methods this can be accomplished'. It is to be hoped that this work will be extended by using photronreflectometric comparisons which may prove more satisfactory than any of the serological tests used in Cumley's laboratory.

6. Future Possibilities

The main difficulty encountered in most serological studies of an entomological nature has been the problem of obtaining antisera of high specificity, titre and avidity. Much insect material appears to have a low antigenicity and in addition the usual antiserum producer, the rabbit, is notoriously unpredictable in its antibody producing capacity. The latter problem is being studied by Dr. Carl Cohen at the Jackson Memorial Laboratory, Bar Harbour, Maine, who hopes to breed selectively from high-antibody-producing rabbits (Boyden 1953). This is necessarily a long term project and early results are unlikely. Recently, at Ottawa, Downe (1955), showed that prenatal exposure of rabbit embryos to chicken serum renders them able after birth to produce more highly specific anti-avian serum than has hitherto been possible. This is a very encouraging result as it points the way towards a technique of increasing the specificity of antisera in a simple way without the tedious absorption methods used, for example, by Weitz (1952).

The report of Hall and West (1954) that very low titred antisera of high avidity can be used in serological studies of predator-prey relationships is also encouraging. Telfer (personal communication) has found little difficulty in producing antisera for use in Oudin technique studies; my own limited experience has been the same. The Oudin technique, with its long reaction times and interface

stability, promises to be of considerable value in entomological studies especially where low antigenicity is a problem.

There is obviously a very wide field for future serological studies in the entomological field. Photronreflectometer techniques have scarcely been used in the study of the many problems of insect taxonomy which exist. Problems of conspecificity, sympatric and allopatric speciation and the correlation of previously unrelated males and females as well as larval and adult forms are obviously amenable to serological study. Many of the present phylogenetic groupings of orders and infra-ordinal groups would profit from serological study. The present large quantity of antiserum (3.6 ml.) required to produce a complete photronreflectometric curve obviously needs to be reduced if valuable antisera are to be conserved and the provision of more micro methods seems to be an urgent need.

In the physiological field any study involving insect proteins is likely to be most profitably approached by serological techniques. Ecological problems such as the relative attractancy of the hosts, for haematophagous insects, or of plant nectars for, say, Dipterous species, could all be tackled with precipitin technique.

There is at present little realization of the broad applicability of serological techniques in entomology and it is hoped that this review will serve to underline some of the problems which might be approached by such methods.

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BOOK REVIEW

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Digestion in Insects by *D. F. Waterhouse;* Some Aspects of Intermediary Metabolism of Carbohydrates in Insects by *M. Rockstein;* The Physiology of Insect Cuticle by *V. B. Wigglesworth;* The Comparative Morphology of the Insect Head by *E. M. DuPorte;* Cytogenics and Systematic Entomology by *M. J. D. White;* The Taxonomic Significance of the Characters of Immature Insects by *F. I. van Emden;* Caste Determination in Social Insects by *M. V. Brian;* Dynamics of Insect Populations by *M. E. Solomon;* The Syoptic Approach to Studies of Insects and Climate by *W. G. Wellington;* Insect Migration by *C. B. Williams;* Recent Advances in Veterinary Entomology by *A. W. Lindquist* and *E. F. Knipling;* Transmission of Disease Agents by Phlebotomine Sand Flies by *S. Adler* and *O. Theodor;* Genetics of Insect Resistance to Chemicals by *J. F. Crow;* The Mode of Action of Insecticides Exclusive of Organic Phosphorus Compounds by *P. A. Dahm;* Chemistry and Mode of Action of Organophosphorus Insecticides by *E. Y. Spencer* and *R. D. O'Brien;* The Behaviour of Systematic Insecticides Applied to Plants by *S. H. Bennett;* Aerial Application of Insecticides by *F. E. Weick* and *G. A. Roth;* Cotton Insects and Their Control in the United States by *J. C. Gaines;* Insecticidal Control of the Spread of Plant Viruses by *L. Broadbent;* Pollination of Alfalfa and Red Clover by *G. E. Bohart.*

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THE LATE DR. E. A. COCKAYNE, O.B.E., M.D., F.R.C.P., F.R.E.S.

Compiled by C. G. M. DE WORMS, M.A., Ph.D., F.R.E.S.

In view of the wide scope and large field embraced by the writings of the late Dr. Cockayne on so many interesting aspects of Entomology, in particular the Macrolepidoptera of the British Isles, I have considered it of use and interest to those who follow and survive him to compile as complete a list as possible of all his publications in this sphere. His knowledge of the literature, especially on genetical matters, was almost encyclopædic so that much useful information may be gained from reference to many of his publications. They have been arranged so far as possible and convenient in chronological order and cover a period from 1903 till 1956. An asterisk denotes that the paper was noted in the Zoological Record.

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PAPILIO PODALIRIUS L., AS A GENUINE IMMIGRANT (LEP: PAPILIONIDAE)

I was interested in Mr. I. R. P. Heslop's record of the occurrence of a specimen of *P. podalirius* at Willand, Devon, in May, 1895 (1958 *Ent. Gaz.*, **9**: 44). Although the authenticity of the butterfly seems beyond doubt I am not certain how far Mr. Heslop's deduction that it was a genuine immigrant can be accepted.

About that time foreign pupae of *podalirius* were extensively sold in England and the butterflies were often released. In 1900 an uncle of mine (I was then a schoolboy beginner) went to Watkins and Doncaster to purchase me a few pupae of *machaon*. These were nearly all sold out, but he brought me back one and also three pupae of *podalirius*, for which he gave, as far as I can remember, sevenpence each. Two of these duly hatched in 1901, and as even then I had a rule of 'British only' I took them outside the town of Gravesend, where I lived, and released them; no doubt others did the same thing elsewhere.

At the meeting of the City of London Entomological and Natural History Society on 6th January, 1903, Mr. G. H. Heath exhibited a damaged specimen of *podalirius* caught on the Wye Downs. 'Mr W. J. Kaye remarked on the small size of the specimens, which at once pointed it to be a liberated bred specimen.' (Transactions, 1903, p. 6.) It may be significant that Mr. Heslop describes the Devon insect as a small one.

H. C. HUGGINS, F.R.E.S.

65 Eastwood Boulevard,
Westcliff-on-Sea.

DESCRIPTIONS OF THE NYMPHS OF THE BRITISH SPECIES OF *HEPTAGENIA* AND *RHITHROGENA* (EPHEM.)

By T. T. MACAN
(*Freshwater Biological Association, Ferry House, Ambleside, Westmorland*)

The following species have been recorded (Kimmins, 1954) in Britain:

Heptagenia sulphurea (Müll.), 1776.
H. longicauda (Steph.), 1836 (*flavipennis* (Dufour), 1841).
H. fuscogrisea (Retz.), 1783.
H. lateralis (Curt.), 1834.
Rhithrogena semicolorata (Curt.), 1834.
R. haarupi Esb.-Pet., 1909.

H. longicauda was recorded at Reading in 1868, at Staines in 1904, and near Tilford on the R. Wey in May, 1933, when Mr. D. E. Kimmins took a single specimen. I have searched for it on four occasions in the R. Wey and have also visited the Reading neighbourhood without finding it, and have now decided not to delay any longer the description of the other species in the hope that it might turn up somewhere; in any case Schoenemund (1930) gives characters whereby it can be distinguished.

As in previous descriptions of nymphs, differences between species have been sought first on cast nymphal skins whose identity has been established from the imago and the final description has been made from both cast skins and whole nymphs. It is a pleasure to acknowledge the continuing and unfailing kindness of Mr. D. E. Kimmins, who has always been prompt to name adults and to supply data on distribution from the files of the Natural History Museum, and I also thank my assistant, Mr. T. Gledhill, who has made some of the drawings.

Heptagenia sulphurea

Material: In the list that follows the name of the place where the specimens were found comes first, and after it the vice county initials. The figures indicate respectively the number of cast skins and the number of whole nymphs examined. The number dissected is indicated in parentheses.

R. Rothay WL 2 (1) + 1; R. Brathay WL 4 (1) + 0; R. Nidd SY 1 + 1 (1); R. Wey SR 19 (1) + 1; R. Avon SH 0 + 2; L. Gartan ED 0 + 1; L. Sheelin CV 0 + 17 (2); L. Tait SL 0 + 1; L. Erne FE 1 + 0; not recorded 2 + 0.

Length: Most of the English specimens were 9 or 10 mm. long, the Irish generally 11-13 mm. long.

Markings: This is a dark nymph on which the light pattern stands out conspicuously. The dorsal markings of a large Irish specimen

are shown in Fig. 1S, and there is not a great deal of variation on this pattern in the other specimens. The transverse distal white bar shown on abdominal segment 4 in the figure may be absent or it may be fused with the two longitudinal lines to give a U-shaped mark as in Schoenemund's Fig. 135. Likewise the distal mark on segments 8 and 9 may be absent or joined to the paired dots. On all segments the two lines near the centre may be pear-shaped. The tails are conspicuously ringed in black and white, and generally, except at base and tip, two white segments alternate with two dark segments, but on a few specimens the white areas are a little smaller than this. The legs are marked as in Fig. 1, except that in some specimens the basal white area is split into three separate flecks.

Gills: The first, fourth and seventh gills are shown in Fig. 2S. It will be noted that there is a tuft of filaments on the seventh gill.

Legs: The upper margin of the femora (that is the margin shown uppermost in Fig. 1) is fringed with fine hairs and at intervals spines (Fig. 3S). The surface is beset with short spines which, under high magnification, are seen to be shaped rather like electric-light bulbs. The fore tibia bears a row of fine hairs down the middle, a few hairs along the upper margin, and scattered irregularly a small number of spines that can only just be made out under a magnification of x 25. Most are bulbous, but a few, especially those along the lower margin, are pointed. The mid and hind tibiae are similar except that they are fringed with hairs along the upper margin and the small spines are more numerous; there is a row of them just inside the upper margin of the hind tibia. On the tarsi there are a few hairs mostly towards the upper margin and a few small spines especially towards the lower margin. These are distinctly bigger and about twelve in number on the hind tarsus. At the distal end of each tibia there is a comb-like structure of hairs and fine spines. The claws have no teeth.

Mouthparts: Figs. 4 and 5 show labrum, maxilla, labium and hypopharynx.

The smallest specimen examined, 4 mm. long, showed the characteristic features mentioned above.

Heptagenia lateralis

Material: Nor Moss Beck WL 3 (1) + 0; High Wray Beck WL 6 (1) + 0; Holbeck WL 3 (1) + 0; Belle Grange Beck WL 1 (1) + 0; Blelham Fishpond Beck 2 + 0; R. Winster WL 1 + 0; Windermere WL 14 (2) + 5 (1); R. Rawthey MY 10 + 0.

Length: Numbers in the different size groups were as follows:

	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12 mm. long.
Becks in Westmorland		4	2	5	0	4				
Windermere	1	0	0	5	1	9	1	0	1	
R. Rawthey in Yorkshire				1	0	2	0	6	0	1

On some specimens the elongate dot extends further forward and joins a light line parallel with the proximal margin of the tergum.

At every second junction between segments of the tails there is a dark ring. A slight darkening on either side of this is often noticeable and on three specimens it extends over the whole segment so that the pattern is like that of *sulphurea*; the contrast between light and dark is, however, never as strong as in that species.

The two dark transverse bands across the femora shown on Fig. 1*F* are of a characteristic reddish-brown colour which, however, fades somewhat in preservative. The gills have an unmistakable shape, and the seventh has no filaments (Fig. 2F).

Legs: The femora are much less hairy along the upper margin than those of the other two species and the hairs are confined to the distal half. The spines on the surface are pointed (Fig. 3F). The tibiae of all three legs are more similar than those of *sulphurea* and *lateralis*, though there is a tendency for the front pair to bear shorter hairs and fewer spines than the others. The distinguishing feature on the tibia of *fuscogrisea* is the greater number of spines along the lower margin. The tarsi also bear more spines, often many more than shown in Fig. 3F. There are generally 2 teeth on the claw.

Mouthparts: Labrum, hypopharynx (Fig. 4F) and labium (Fig. 5F) are distinctly different from those of the other two species. The maxilla is somewhat like that of *sulphurea*.

Heptagenia longicauda

Schoenemund (1930) divides six species of *Heptagenia* into two groups in his key. The first has large tufts of filaments longer than the lamellar part of the gills which is egg-shaped or pointed. In the second group the gill filaments are in tufts smaller and generally shorter than the lamellae. *H. longicauda*, referred to as *H. flavipennis*, falls into the first group. There are no figures of it, but the gill of *H. flava*, from which it is distinguished on colour, is illustrated. The lamella is oval and pointed and there is a great thick mass of filaments covering an area distinctly bigger than the lamella (Fig. 132). The species should be easily distinguishable from the three described above, all of which fall into Schoenemund's second group.

Genus Rhithrogena

I have compared specimens of *R. haarupi* taken in the R. Nith below Thornhill in Dumfries-shire with specimens of *R. semicolorata* from the Lake District, and have failed to find any difference between them. True, *R. haarupi* tends to be half as big again as *R. semicolorata*, lengths of nymphs ranging from 11-13 mm. compared with 7-10 mm. with a mode at 8 mm. but size is of doubtful value as a distinguishing feature, for there is evidence that it varies with temperature. Macan (1957a) measured a large number of nymphs of *R. semicolorata* during a stream survey and his findings agree with the above figures, most full-grown nymphs being 8-10 mm. long (see

Macan 1958 for a histogram). A few were larger and 15 fell into the 11-12 mm. size group. Of these 15, no less than 11 were found in tributaries, one of which was shown to have a more equable temperature than the main stream. Harker (1952) studied a stream which probably never got as warm as Macan's and in it found that *R. semicolorata* ranged up to 14 mm. in length. Thus the largest Lake District specimens of *R. semicolorata* are as large as the smallest specimens of *R. haarupi*, but those studied by Harker are of the same size.

Kimmins (1954) records that *R. haarupi* is 'common but local on large rapid rivers' and Harris (1952, p. 255) gives a distribution map to which the R. Nith record mentioned above must now be added. *R. semicolorata* occurs in rivers also but is particularly characteristic of small stony streams (Macan, 1957b).

Key

1. First gill very large and meeting its fellow beneath the body. A dark dot in the centre of each femur ..... *Rhithrogena semicolorata* and *haarupi*
– First gill small and like the others in shape (Fig. 2). Markings on femora not like this 2
2. Filamentous part of the gill as large as the lamella ..... *Heptagenia longicauda*
– Filamentous part of the gill smaller than the lamella 3
3. Rather little or no pattern on body and tails; a light cross-shaped area on the femora separating four dark areas which are often darker in the middle so that four lines, each parallel with the margin, are apparent (Fig. 1*L*). Upper margin of femur fringed with hairs which, if folded back would extend more than half-way across the femur (Fig. 3L). Gills narrowing gradually to a rather blunt point (the seventh without a tuft of filaments) (Fig. 2L) ..... *H. lateralis*
– Black-and-white nymphs with conspicuous pattern (Fig. 1); femora with transverse bars (Fig. 1). Hairs along upper margin of femur much shorter (Fig. 3). Gills of other shape (Fig. 2) ... 4
4. Gills rather small and rounded at tip; last with a tuft of filaments (Fig. 2S). Femora with black transverse bands (Fig. 1*S*); fore margin closely beset with short hairs and spines (Fig. 3S) ..... *H. sulphurea*
– Gills large, produced into a point; last without a tuft of filaments (Fig. 2F). Femora with two reddish-brown bands (Fig. 1*F*); fore-margin with a few short hairs along the distal part (Fig. 3F) ..... *H. fuscogrisea*

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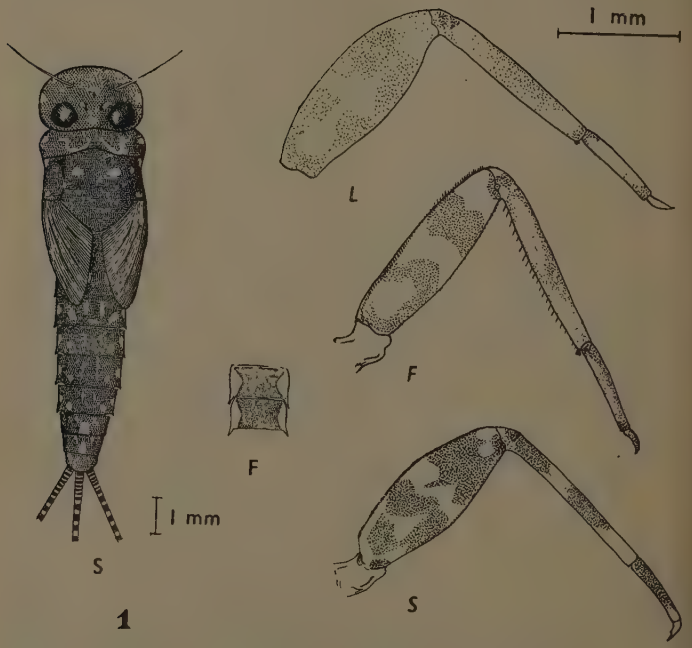


Fig. 1. Markings on upper surface of body and of legs of *sulphurea* (S), *fuscogrisea* (F) and *lateralis* (L).

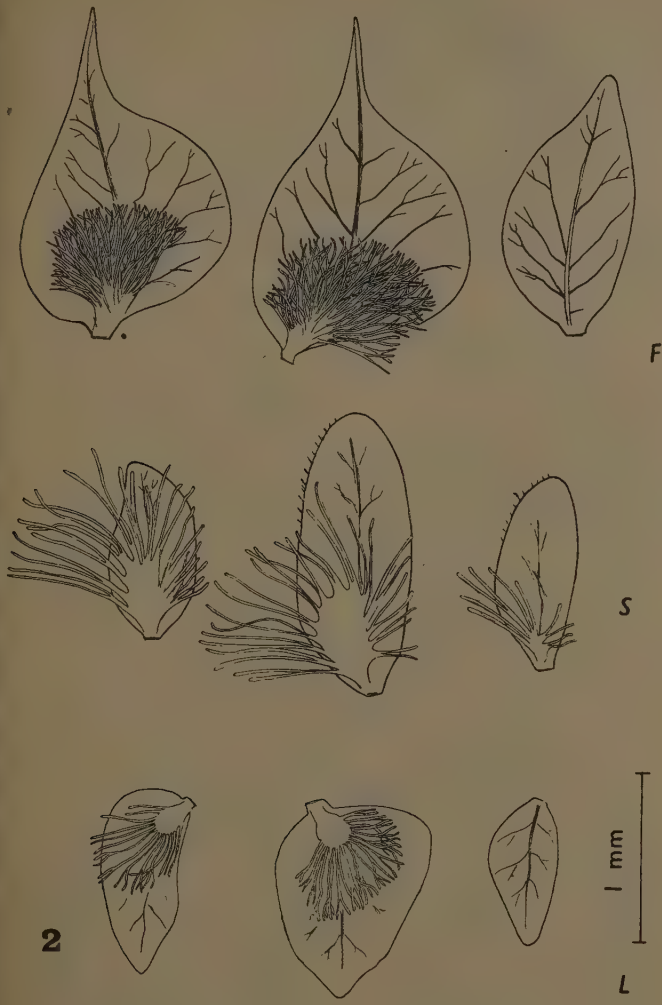


Fig. 2. First, fourth and seventh gills of *lateralis* (L), *sulphurea* (S), *fuscogrisea* (F).

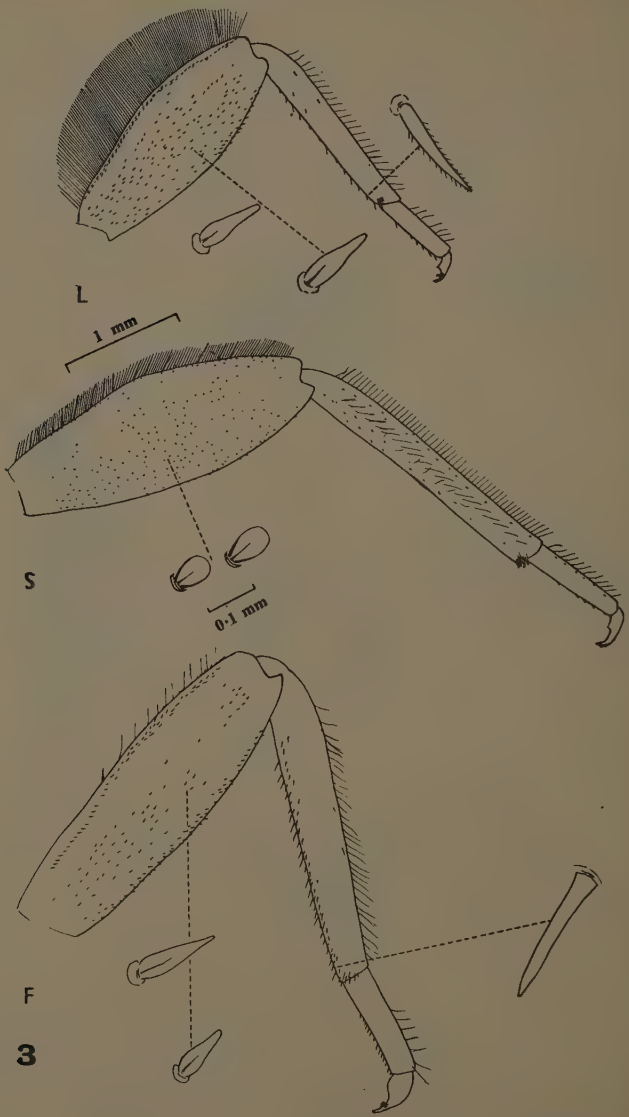


Fig. 3. Middle legs of *lateralis* (L), *sulphurea* (S), *fuscogrisea* (F).

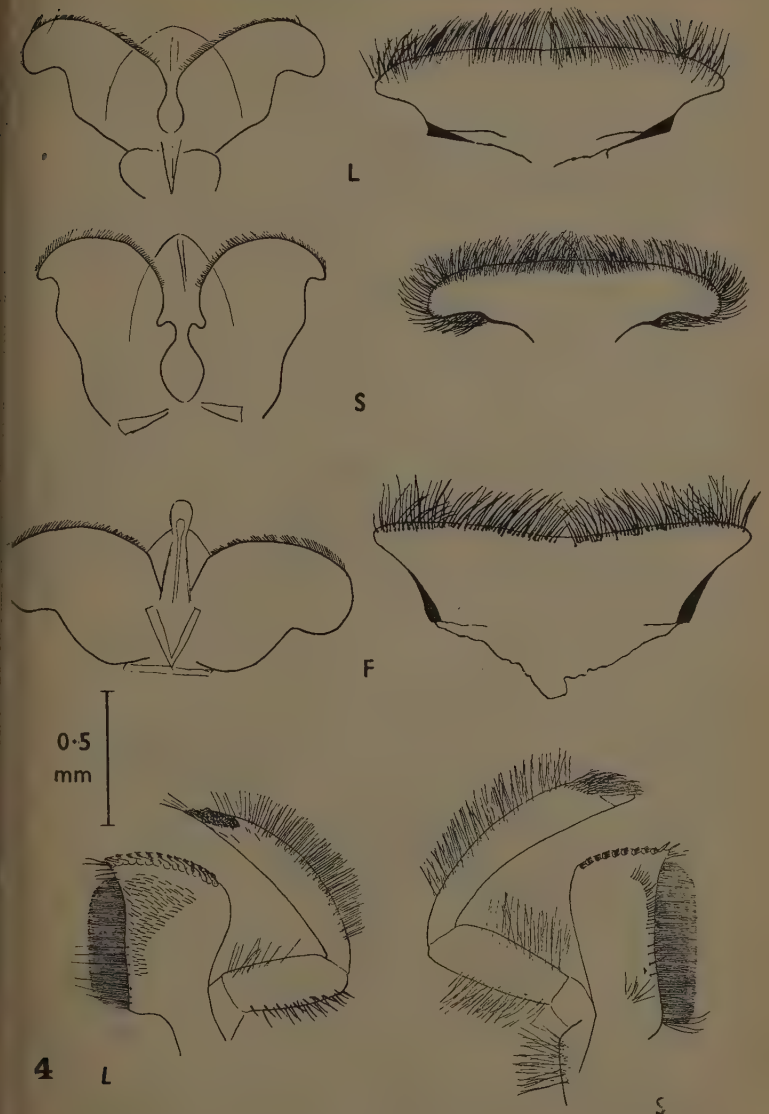


Fig. 4. Hypopharynx, labrum and maxilla of *lateralis* (L), *sulphurea* (S), *fuscogrisea* (F).

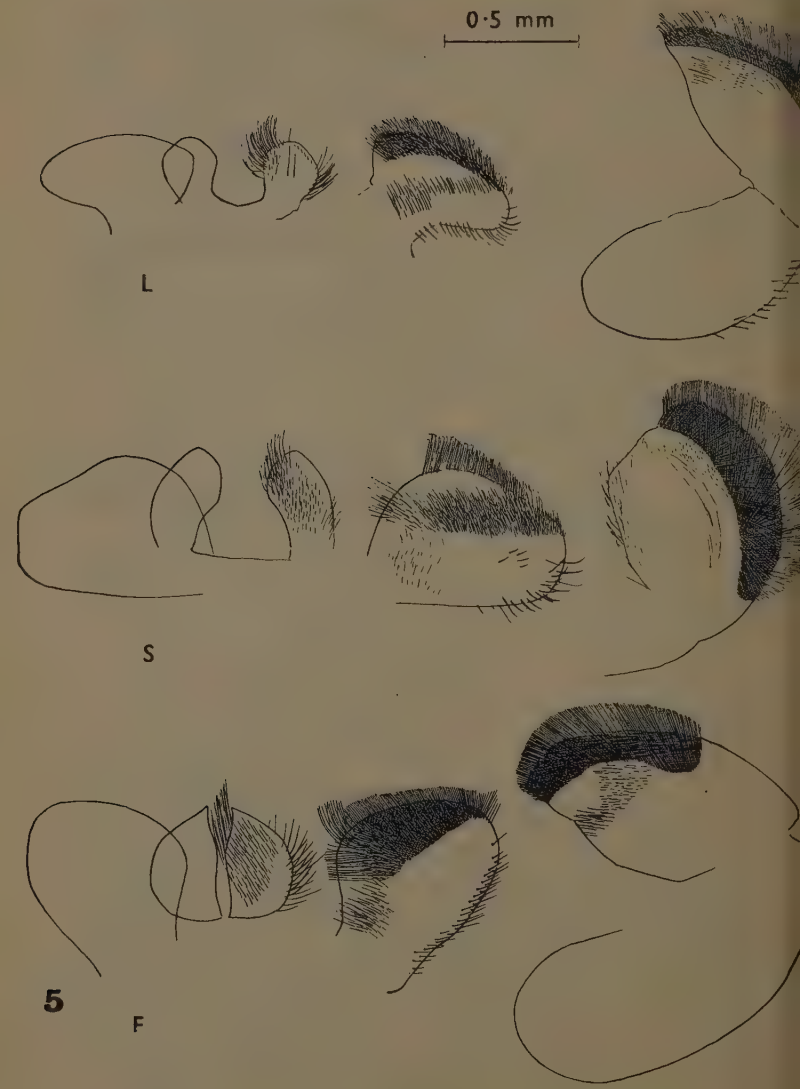


Fig. 5. Labium of *lateralis* (L), *sulphurea* (S), *fuscogrisea* (F).

BOOK REVIEW

A reclassification of the Order Odonata, by Lt.-Col. F. C. Fraser, 1957. Royal Zoological Society of New South Wales. 133 pp., 62 black and white illustrations. Price 12s. 6d. 15s. in U.K.

All entomologists who had an inkling that Lt.-Col. Fraser was working on this project have waited in eager expectancy for the published result. The author, who has devoted a lifetime to the study of the Odonata, has an unrivalled knowledge of the wing venation, and who is also an accomplished artist, has to be congratulated on this most important contribution to Odonate literature.

Although primarily based on the Tillyard and Fraser Classification (Tillyard & Fraser, 1938-1940. 'A reclassification of the order Odonata—', *Australian Zoologist,* **9**: 125-169, 195-221, 359-396), the opportunity has been taken to incorporate much fresh information, to modify some views, and to revise the classification in the light of nearly twenty years' further study.

The origin and descent of the Odonata is graphically illustrated by a diagram in which five dominant ordinal characters are employed. Each represented by a different type of line (Anal-crossing, eyes separated, primary antenodals present Zygopterous ovipositor present and IRiii and Riv recessed to proximal of nodus) mark the descent from the Protozygoptera to recent forms. Some thirty pages are devoted to the fossil history and venation. Recent research prompts the theory convincingly postulated that the narrowing of the wing has been a progressive process, firstly eliminating the main veins MP and CuA and finally fusing the marginal veins Sc and IA with the anterior and posterior borders of the wings respectively.

Keys are provided down to subfamily level and under each heading the group is clearly defined, the venation and other morphological characters discussed with relation to allied groups and larval characters of importance enumerated where known. After each family or subfamily has been discussed there follows a list of the fossil and recent genera with notes on their world distribution.

Within the Suborder Zygoptera recent taxonomic changes include in the family *Platystictidae the* erection of *Palaemnematinae* nov. subfam., to embrace the single Neotropical genus *Palaemnema* Selys. The *Protoneuridae* now contain four subfamilies—*Protoneurinae* nov. subfam., *Disparoneurinae* nov. subfam., *Caconeurinae* nov. subfam., and *Isostictinae* Fraser. The large and highly successful family *Coenagriidae* containing about sixty genera is divided into six subfamilies of which the *Amphicneminae* nov. subfam., has been erected to include the assemblage of forms previously contained in *Teinobasis* Kirby. Species in which the female is armed with a ventral abdominal spine on the apical margin of segment eight are now all included in the *Ischnurinae* nov. subfam. *Lestinoidea* has been adopted in place of *Lestini* in accord with other superfamilies mentioned. The *Lestidae*

are now classified in accordance with the author's work (Fraser, F. C., 1951, Outline of a new classification for the legion Lestes, Selys, *Ent. News*, **62**: 61-69) and the allied family *Megapodagriidae* is completely overhauled.

We find in the Suborder Anisoptera that the Cordulegasters are raised to the rank of a superfamily *Cordulegasteroidea*, the Synthemines formerly at generic level within the family *Corduliidae* are now raised to family level by reason of the primitive thickened state of the primary antenodals. The Urothemis group formerly included within the *Libellulidae* are now contained within the new family *Macrodiplactidae* and placed between the *Corduliidae* and *Libellulidae*. Formerly the *Libellulidae* contained ten subfamilies, two new ones have been erected—*Zygonictinae* to include the genera *Zygonyx* Selys, *Olpogastra* Karsch and *Zygononoides* gen. nov., and *Pantaliinae*, which includes genera with the most highly specialized venation. The Bibliography runs to three pages and finally an adequate Index is provided. Only two printer's errors were noticed. On the illustration depicting the origin and descent of the Odonata for '*Macrodiplacidae*' read '*Macrodiplactidae*', and on p. 118 for '*Microthyria*' read '*Micrathyria*'. The numerous illustrations form an important feature of this work and, although one of the most difficult subjects to depict, are all beautifully executed by the author and have not suffered by reduction. Very reasonably priced, this work will be in great demand by all Odonatists and should find a ready sale to all interested in taxonomic and curatorial work.

A. E. GARDNER.

RECENT LITERATURE

We have recently received a reprint of 'Forest Sawflies of Southern Ontario and their parasites', 1957, written by Henri Raizenne of the Forest Biology Division of the Canadian Department of Agriculture, Ottawa. This 45-page paper with a loose distribution chart gives an exhaustive compilation of data on the 90 species of sawflies collected from forest trees in southern Ontario from 1936 to 1952. At the Ottawa Forest Insect Survey Laboratory nearly 135,000 larvae were reared from 5,264 collections. The Pamphiliidae are omitted owing to taxonomic confusion and data on parasitism of some leaf miners and borers remains incomplete owing to rearing difficulties. Each species collected has its food plant recorded, the distribution, seasonal history, notes of general interest and where known the details of parasites bred from the sawfly larvae.

A.E.G.

COLLECTING IN THE FENS

By R. G. WARREN

On 21st July, 1956, my friend Leslie Watson and I arrived at Peterborough equipped with permits for the four Nene Valley Reserves of the Nature Conservancy—Wood Walton Fen, Holme Fen, Monks Wood and Castor Hanglands. Neither of us had any previous experience of collecting in the Fens, and although the weather of the past few weeks had not exactly been of the sort to give rise to optimism, yet we hoped that breaking new ground would produce something of interest.

Sunday morning, 22nd July, was fine; Mr. W. E. Russell called for us and we set off to Wood Walton Fen. We were met at the entrance by Mr. Gordon Mason, the Warden, and before many minutes had passed we saw our first '*dispar*'. While it was a pleasure to see these gorgeous insects on the wing it was disappointing to learn that they are only maintained by breeding in captivity and releasing the butterflies each year. Vulnerability to ichneumon attack is the trouble and it poses a problem which must be solved before any attempt at re-introduction can be completely successful—how to raise the population of a species to a level at which it can withstand such attacks.

I was interested to see the striking little *Ethmia funerella* (F.) in some numbers sitting on posts and tree trunks; its food-plant, comfrey, was growing in the ride, though it must be on other plants as well since it occurs in Staffordshire in places where there is no comfrey. Another 'micro' which must have other food-plants besides its recorded one is *Laspeyresia orobana* (Treit.), of which we took one each; there was certainly no *Vicia sylvatica* in the vicinity, nor is the plant recorded from Wood Walton.

Searching the trunks of willows on this and later visits yielded examples of the three Tortrices, *Argyroploce semifasciana* (Haw.), *hartmanniana* (L.) and *salicella* (L.)—also an object lesson in the most effective camouflage possessed by some of the forms of *Hydriomena furcata* (Thunb.)!

A few *Ophiusa* (*Lygephila*) *pastinum* Treit. were disturbed from among the herbage; they have the undulating flight typical of the Plusiidae. One or two *Xanthorhoë quadrafasciaria* (Clk.) were resting on the walls of the bungalow but were too wary to be boxed, and Watson found a *Leucania straminea* (Treit.).

In the evening we found a patch of waste ground on the outskirts of Peterborough (actually the margin of the town rubbish dump) which proved quite productive. *Thymelicus lineola* (Och.) was common—apparently it completely replaces *sylvestris* (Poda) in the Fen country but is absent or very scarce on the higher ground—and

among the micros we took *Phalonia dubitana* (Hueb.), *Laspeyresia compositella* (F.) and *Platyedra* (*Phthorimaea*) *malvella* (Hueb.).

On 23rd July we visited Castor Hanglands; the day was sunny but there was a strong breeze which was not at all favourable for collecting on the heath. I flushed a *Eustrotia uncula* (Clk.) near the pond at the eastern margin. Butterflies were plentiful enough, especially *Melanargia galathea* (L.), and a number of *Argynnis paphia* (L.) and *Limenitis camilla* (L.) were seen. I noticed that the dominant Crambid of the heaths was *perlellus* (Scop.), about 50 per cent. being the brown-streaked form originally called *warringtonellus* Stainton.

The next day was cloudy with a very strong westerly wind; Monks Wood was the obvious choice for such conditions and we spent two or three hours beating in the most sheltered rides we could find. Among the species taken were *Cosmia pyralina* (Schiff.), *Laspeyria flexula* (Schiff.), *Acrobasis tumidella* (Zinck.) (*zelleri*, Rag.), *Argyroploce capreana* (Hb.) and *A. branderiana* (L.). Watson found a Vanessid larva which had suspended itself from an elm twig for pupation; our first thought was *polychloros* (L.), but we found it was *c-album* (L.). Transporting this back to Peterborough without disturbing it was not easy, but it was achieved by arranging the piece of twig in a tin so that the larva hung free; there were some anxious moments on the bus journey, but in the end all was well. The larva pupated the same evening and the butterfly, a fine var. *hutchinsoni* emerged a few days later.

The most exciting capture, however, was just as we were about to leave the wood, when what appeared to be a shrivelled leaf on a bush under a maple tree revealed itself on closer examination as a freshly-emerged *Lophopteryx cucullina* (Schiff.).

We had arranged a trip to Holme Fen with Mr. S. W. P. Pooles in the evening and we arrived on the ground at about 8.30 p.m., B.S.T. The wind had dropped and it was still and warm. Birch trunks and telegraph poles along the Holme Lode were sugared and we did some 'dusking' while waiting for it to be dark enough to use the lamp. *Sterrha fuscovenosa* (Goëz.) and *S. emarginata* (L.) were common and one or two *Xanthorhoë quadrifasciaria* were beaten from the birches. From about 9 p.m. onwards we began to find *Arenostola fluxa* (Hb.) (*heilmanni* (Evers.)) and *A. phragmitidis* (Hb.) on the reeds; both were in fresh condition and in moderate numbers. The sugar did not produce very much, the best things being *Apatele leporina* (L.), *Parastichtis suspecta* (Hb.) and *Apamea ypsillon* (Schiff.). A 300 c.-p. Bialaddin lantern was operated with a sheet on a footbridge crossing the drain from 10 p.m. to about 1 a.m. Among the profusion of moths in attendance the following were the more interesting: — *Eilema griseola* (Hb.) (common), *Leucania pudorina* (Schiff.) (one), *Nymphula stratiotata* (L.), *Chilo phragmitellus* (Hb.), *Eucosma nigromaculana* (Haw.), *Endothenia fuligana*

Haw., *Argyroploce achroleucana* Hb., *Brachmia gerronella* (Zell.) and *Coleophora deauratella* Zell.

I had noticed on the birch trunks before dusk and later at the sugar numerous examples of a Gelechid which I assumed to be a large, strongly-marked form of *Anacampsis populella* (Cl.). I have since seen a specimen of *A. betulinella* at the British Museum and have no doubt that the Holme Fen examples were referable to this species. Unfortunately, I only took one specimen but this is certainly *betulinella*.

The 26th July found us at Wood Walton Fen again; it was a warm sunny day and I was interested to see the three Argynnids—*paphia* (L.), *cydippe* (L.) and *aglaia* (L.) present in the same locality. The first two were flying together and visiting the same clumps of thistles, but *aglaia* was only seen in a different part of the Fen. On this occasion we penetrated farther into the Fen and reached an area of rather different vegetation growing on acid peat. Here, resting in crevices of birch stems, a number of *Telphusa alburnella* (Dup.) were found; in habit and general appearance they resemble the common *T. proximella* (Hb.) but are readily distinguishable once the true *alburnella* has been recognized. We subsequently found *alburnella* also at Monks Wood and Holme Fen.

On 27th July we visited Bedford Purlieus, a wood on calcareous soil about eight miles west of Peterborough. Beating the hedgerows in a lane along the wood margin and undergrowth just inside the wood produced some of the Geometers to be expected in such places—*Hemistola immaculata* (Thunb.), *Melanthia procellata* (Schiff.), and *Epirrhoe rivata* (Hb.), but also, most surprisingly, a single *E. tristata* (L.), very far astray from its usual haunts. Four species of 'footman' also occurred—*Nudaria mundana* (L.), *Miltochrista miniata* (Forst.), *Cybosia mesomella* (L.) and *Eilema lurideola* (Zinck.). Among the micros the best find was *Cerostoma lucella* (F.), of which we beat out four specimens from scrub oak. Like others of the genus they do not fly when disturbed but fall to the ground and are easily lost in long grass.

So far we had been favoured with excellent weather, at least by 1956 standards. That evening, however, a violent thunderstorm developed, continuing well into the night with further thundery rain during the morning of the 28th. In the afternoon Mr. Russell took us to a wood in the Castor Hanglands area which we had not previously visited, but collecting in such conditions with soaking vegetation was not an encouraging prospect and we did not find anything of note.

That night, and nearly every other night for the remainder of our stay, *Euxoa nigricans* (L.) came in numbers and considerable variety to a lighted window of the house in Peterborough where we were staying. It was often the only species in evidence, but among other visitors were single specimens of *Spaelotis ravida* (Schiff.), *Thalpo-*

phila matura (Hufn.) and *Hadena trifolii* (Rott.), and a few of the ochreous form of *Cryphia perla* (Schiff.).

On 30th July we paid a second visit to Monks Wood. A strong westerly wind made collecting almost impossible, even in thick cover. We found the second brood of *Lithocolletis sylvella* (Haw.) beginning to emerge and collected some mined leaves of maple from which we bred a series of the moths. We also collected leaves of *Pyrus torminalis* with mines of at least two species of *Lithocolletis,* one on the upper and one on the underside of the leaves, but from these we bred only a single *L. corylifoliella* (Haw.) The failure was probably due to the leaves drying up too quickly.

The following day we re-visited Castor Hanglands in rather better weather. There was some sunshine but still more wind than we could have wished. The interest was mainly among the smaller moths; among *Inula dysenterica* we disturbed a number of *Psammotis crocealis* (Hubn.) and one *Oidaematophorus lithodactylus* (Treit.). *Phalonia roseana* (Haw.) was rather common among teasels, some faded but some with a lovely fresh rosy tint. We noticed empty chrysalis cases protruding from one or two of the previous year's teasel-heads, and on opening some we found traces of the larvae having fed in them. A few live pupae were also found, but these appeared too large for *roseana;* they proved to be *Endothenia gentianana* (Hb.). Other species of micro-lepidoptera noted were *Laspeyresia ianthinana* (Dup.), *Thiotrica subocellea* (Steph.), *Acompsia cinerella* (Cl.) and *Hyponomeuta plumbella* (Schiff.).

Rain started on 1st August soon after we set out for Wood Walton Fen and grew steadily heavier. A *Cosymbia pendularia* (Cl.) was found on a birch trunk, and on the wall of the bungalow where we spent most of our time sheltering was a *Philereme transversata* (Hufn.) A small Tortrix rather common on stems of aspen proved to be an ashy-grey form of *Eucosma nisella* (Cl.).

We made a further visit to Wood Walton Fen the following day in much better weather conditions; after some drizzle in the morning there were sunny periods and it became very warm. In the morning we worked the area around the bungalow; a number of *Eilema griseola* were taken, also one *Zenobia subtusa* (Schiff.). Later we made our way to the acid peat area but did not find anything of special interest. A Crambid which we hoped was *silvellus* (Hb.) proved to be only *pascuellus* (L.). The most striking feature was the enormous concentration of *Tabanidae* and *Anopheles* whose attacks we had to endure.

I noticed large numbers of *Lithocolletid* mines in the leaves of an alder tree. From some of these I bred *L. kleemannella* (F.) as well as *L. alnifoliella* (Hb.), while *L. stettinensis* Nicelli was also present, the mines of the latter species being recognizable by the fact that they are on the upper surface of the leaf.

Our holiday concluded with another night at Holme Fen with Mr. Pooles. The weather caused us some anxiety—there were thundery showers in the afternoon and further rain during the evening. Our procedure was the same as on 24th July, but on this occasion there were few insects sitting on the reeds and other vegetation, no doubt because it was wet; however, by way of compensation light was even more productive. Steady rain began soon after we had put on the sugar, but ceased after about twenty minutes and there was only intermittent drizzle afterwards. The sugar was fairly well attended but nothing outstanding was taken; a *Habrosyne derasa* (L.) was netted by the roadside.

After one round of the sugar we turned our attention to the sheet and found insects arriving at a rate that kept us busy for the next two hours. Some species which would no doubt be commonplace to collectors from the south of England were of interest to us—*Malacosoma neustria* (L.), for instance, which is not met with in our North Midlands area, was in large numbers and very variable, and there were a few *Lymantria monacha* (L.). *Eilema griseola* (Hb.) and *E. complana* (L.) were in hundreds, the former including one or two of the *stramineola* form. Some *Miltochrista miniata* (Forst.) were in lovely fresh condition. Other species not seen on the previous visit were *Coenobia rufa* (Haw.), *Pyralis glaucinalis* (L.) and *Endothenia ericetana* (Hb.).

We came away well satisfied with the fortnight's work; not only had we filled some long-standing gaps in our collections, but we had found considerable interest in recording as many as possible of the species we saw for the Nature Conservancy's Reserve lists. The numbers of species of Lepidoptera noted were, for Wood Walton Fen 128, Holme Fen 120, Monks Wood 82 and Castor Hanglands 73.

The Nature Conservancy has been appealing for fauna lists from visitors to their Reserves, and we hope that other entomologists will find, as we did, that compiling such lists adds a good deal of interest to a holiday.

R. G. WARREN.

Wood Ridings,
32 Whitmore Road,
Trentham, Staffs.
8th April, 1957.

THE BEGINNING OF A BELATED SPRING?

As a matter of interest in a year with a spring as severe as the present, I saw the first Orthosia—*O. gothica* (L.) (Lep: Caradrinidae) —on the night of 24th March at Wokingham, Berks. In the headlights of the car a number of moths were seen—a decided improvement on snowflakes!

E.W.C.

Feltham, Middlesex.

LOGIAN, JACQUINIAN AND LEDIAN

Former generations of entomologists had a way, when naming (or renaming) a species, of presenting a latinized form of a person's name; and then of subsequently dubbing the species in the vernacular, not directly after the person in question, but by means of a further derivation from the said latinized form. This practice occurred primarily in the Tortrices (the resultant English names being standardized to a termination in *-ian*), as is well illustrated in Wood and Westwood's *Index Entomologicus*. Thus there were *Argyrotoxa bergmanniana* Linn. ('Bergmannian') and *A. conwayana* Fabr. ('Conwayian') and many more. I should mention that many of the English names in that work had been already used by Haworth, and earlier authors, though not always in connection with the identical species. But I had had to discover, quite without precept, that the *Index Entomologicus* provided the only practicable starting point, however far one might have to range, for a recension of the English Nomenclature of the Microlepidoptera.

In the course of very many years of tracing in and adapting from the literature English names for our Microlepidoptera, in all of the numerous cases—except three—of a double derivation of the type exemplified I was able to identify the persons referred to. In the two named, and most other cases, the process was easy. Thus 'Bergmannian' I altered obviously to 'Bergmann's', 'Conwayian' to 'Conway's', and so on. To these adjectival elements were added the substantive or general names, in great part derived from the literature, which had been applied to the groups concerned. Other cases were much more difficult: it took considerable research to discover, for example, that 'Modeerian' was actually derived from Modée whom Linnaeus had commemorated with one of his names for the species: this, at present known as *Tortrix rurinana* Linn., being in consequence now called in English 'Modée's Twist'.

As stated, three species defied my efforts to elucidate the original personages after whom they had been called: the adjectival portions of their English names in my Check-list therefore necessarily remaining exactly as in the *Index Entomologicus* (pp. 160, 139 and 140, respectively, in the 1854 edition). The three species in question, all Tortrices, are:

Peronea schalleriana *Linn.* (*logiana* Schiff., *tristana* Hübn.) Logian Button.

Hemimene alpinana *Treits.* (*quaestionana* Zell., *jacquiniana* auctt.) Jacquinian Drill.

Laspeyresia ianthinana *Dup.* (*lediana* auctt.) Ledian Piercer.

I am asking the Editors to publish this note in the very real hope that some of our readers may be able to inform me of the actual personal names in question. Such may be quite patent to someone

else, although to me as cryptic as the proverbial mustard-pot just before one's plate.

The name *logiana* is actually from Clerck (1759). The suggestion was made to me, in lit., by the late T. Bainbrigge-Fletcher that the person in question may have been one Log or Logi. But it seems to me just as possible that there may have been a Scotsman of the name of Logie who had such honour.

The name *jacquiniana* dates from Schiffermüller (1775). I note that Linnaeus named a falcon after one Jacquin, so I think it is possible that this moth may have been named after the same person. But I should be interested to have confirmation.

The name *lediana* dates from Linnaeus (1758). Bainbrigge-Fletcher pointed out that most of Linnaeus's friends and pupils were botanists rather than entomologists; and that the original for this name might have to be sought among the former. Lede seems a possibility, but I have no knowledge of any such person.

I. R. P. Heslop.
'Belfield', Burnham-on-Sea, Somerset.
19th January, 1958.

A NOTE ON SOME DRAGONFLIES FROM SCOTLAND IN 1957 (ODONATA)

I am indebted to Messrs. J. D. Bradley and D. S. Fletcher for the opportunity of examining a small collection of Odonata taken on the Isle of Rhum, Inner Hebrides, 10th-16th July, 1957.

The following species were represented: *Cordulegaster boltoni* (Don.) ♂ Kinloch; *Aeshna juncea* (L.) ♂ Kinloch; *Libellula quadrimaculata* L., ♂ Kinloch, ♂ ♀ Mulloch Mor; *Sympetrum nigrescens* Lucas 2 ♀ ♀ Fionchra; *Enallagma cyathigerum* ♂ Kinloch.

Mr. A. McCrae kindly sent me specimens of *S. nigrescens* from Kerrisdale, Western Ross, and Dr. W. K. Ford gave me the opportunity of identifying two ♂ *nigrescens* taken by Mr. R. A. Dollman from Giola, Stornoway, Isle of Lewis, on 22nd June, 1931.

A. E. Gardner.
29 Glenfield Road,
Banstead, Surrey.

ODONTAEUS ARMIGER (SCOP.) IN BUCKS. (COL: SCARABAEIDAE)

On 30th June, 1957, I took a ♀ specimen of the rare Scarabaeoid beetle *Odontaeus armiger* (Scop.) in my mercury vapour trap at Chalfont St. Peter. I am indebted to Mr. E. B. Britton for identifying the specimen.

Sir Eric Ansorge.
'Timbers', Welders Lane,
Chalfont St. Peter, Bucks.

'PROTRUSIVE' GROWTH OF *DUPLEX* CAUDAL GILLS IN ZYGOPTERA (ODONATA)

By NIALL MACNEILL

In the caudal gills of the nymphs of Zygopterid dragonflies two principal types can be recognized. In both cases the embryonic organ is a simple ferular undivided structure.

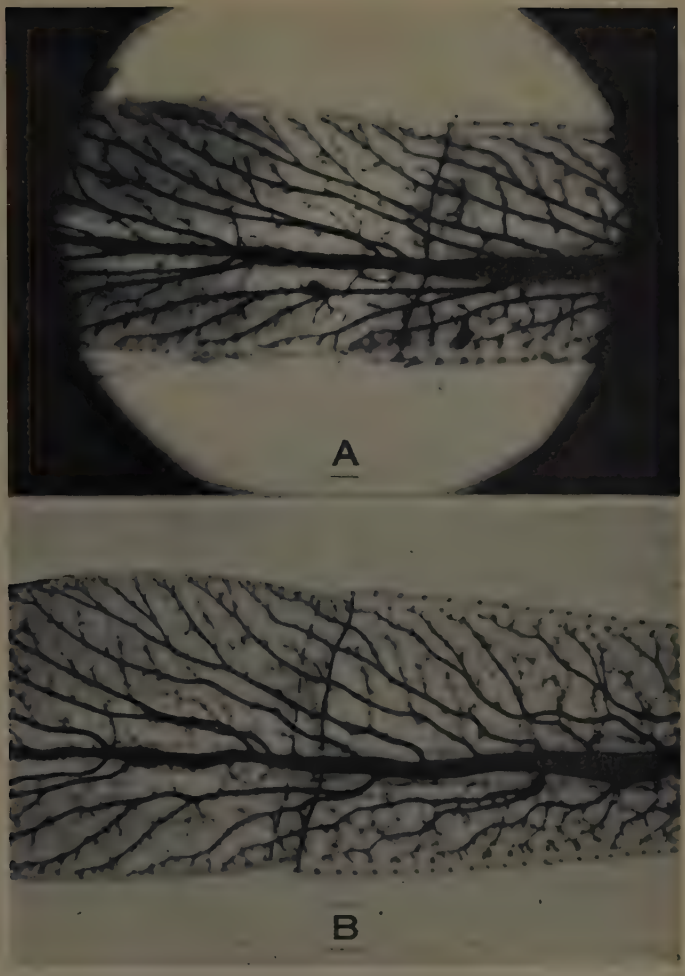
In certain groups this undivided character is retained throughout the larval life. The appendages may undergo much cross-sectional modification but retain a unitary structure and uniform sclerotization. I propose that these should be called *simplex gills*.

In other groups, comprising it is believed the entire remainder and certainly the majority of described species, these organs are of the type which Tillyard referred to as "two-jointed". These include many instances in which the two-part character may be superficially inconspicuous and are not at all restricted to cases in which the division is transverse or approximately so. From the few life-histories available it is inferred that departure from simple structure—even in those cases in which two-part form is prominent at a later stage—may not become visible until 4th, 5th or even 6th instar. I suggest that gills of this type should be called *duplex*.

From certain observations I reached the belief that the distal component of these duplex gills is developed as a stage-by-stage protrusion of an already organized structure from within the integumental confines of the proximal part.

The pair of photographs here reproduced (Plate 5) verify this hypothesis. Without killing the insect or amputating the organ one of the gills was photographed during the penultimate stadium (A) and re-photographed after ecdysis into final instar (B). It is clearly seen from these pictures that a 'zone' of the structure, defined by recognizable peculiarities of tracheal network, has migrated from an 'antenodal' to a 'postnodal' position. Corresponding results were obtained in six other cases similarly photographed, including examples of earlier instars. All seven subjects were *Agrionidae* (= *Coenagriidae*), but there is no reason to think that the phenomenon is confined to that family.

I am in no doubt that the entire 'postnodal' growth arises from a succession of displacements of this kind, including cases in which the protrusion is transverse as well as apicad. Also it would appear that in some cases it may be accompanied by contraction or degeneration of the stronger sclerotization by which the proximal part is distinguished.



Photograph A taken on 21st Nov., 1957. Inside aspect of mid-length part of left lateral gill. Larva in penultimate instar.

Photograph B taken on 18th Feb., 1958. Same gill 'exuvia' still alive'. Larva in final instar. Overdrawn firm line indicates position of 'nodal line'. Pecked line indicates 'zone' of structure which from an antenodal position in A penult. instar, has migrated by 'protrusive' growth to position in B (final instar).

Agrion pulchellum (Van der Lind.) or **A. puella** L.).

DESCRIPTIONS OF THE EARLY STAGES OF *COSYMBIA PUPPILLARIA* (HUBNER) LEP: GEOMETRIDAE

By G. HAGGETT

The insects described in these notes are of three broods reared from a moth taken in the Scilly Isles by Mr. Robin Mere, to whom I am indebted. I have also to thank Mr. George Hyde for providing the fine photographic studies.

The Egg. Pearly white when laid, changing to a soft pink after one day, then deepening to coral red and frequently blotched with vermilion, finally darkening to leaden purplish before hatching. An average of four days is spent in this stage. In captivity eggs were laid most freely along the crinkled margins of the older leaves of Holm Oak *Quercus ilex* L.

Description of the first instar larva. When newly hatched the larva measures rather over 1 mm. long and is basically a pale whitish-green, but it is heavily marked with a deep purplish-brown rounded patch on each of the first five abdominal segments with a corresponding patch on the ventral surface, and further dark brown suffusion over the entire dorsum of the rest of the abdomen on to the claspers: the dark patches are narrowly connected at the intersegmental divisions. The thorax is weakly marked with brown on the dorsum and again laterally. Head and true legs pale reddish brown.

Description of the second instar larva. Of the same pattern as the preceding stadium but the dorsal marks less intense, with the ground colour a little deepened. The general appearance is more of a greenish-olive hue, inclined to brown along the dorsum. Thorax with a pale weak dorsal line edged by a darker band and with a further obscure band lower down on the sides. True legs greyish. Head pale brown and striped. Minute short bristles on all segments. Spiracles tiny and situated on a whitish fold of skin.

Description of third instar larva. Similar to the last but with increased mottling and white flecking all over the body and particularly evident at the dorsal segmental divisions where a pair of incurved bolder, short, white streaks are placed to each side of a darker connecting link. General colour more variable, still commonly pale olive with a darker dorsal pattern, others much more brown, even purplish along the dorsum and whiter basically so that the pattern stands in bold relief.

Description of the fourth instar larva. It is in this, the penultimate, stage that the greatest variety of colour forms is found. The dorsal pattern is now of the hooped form that is so characteristic of the adult *Cosymbia* larva, having the anterior part of the hoop consider-

ably darkened but crossed by the bright pair of white streaks. Colour is expressed in a wide but subtle range from dull pinkish olive to ochreous, sienna, smoky-grey, vandyke or chocolate, the dorsal pattern standing clearly on a paler ground of the brightest marked forms while others are of a more uniform, sombre appearance. No really green forms appeared in this instar.

Description of the fifth instar larva. Measures to 22 mm. long when fully grown.

There are only two forms of the larva at full growth, a bright emerald green that varies to darker olive green, and a dull umbrous brown. For a short while after the fourth moult those larvae later to assume the green skin exhibit much variation in colour from soft, greyish-green and yellow green to ultramarine and blueish, but they quickly become a uniform bright green. The brown larvae also begin the last instar much brighter than at maturity.

In both forms the dorsal pattern is now greatly reduced, being discernible in the green larvae only at the very beginnings of the abdominal rings but being rather better developed in the brown. The basic markings of both forms remain constant at maturity, being a delicate pair of whitish lines along the centre of the dorsum, composed of tiny whitish or cream dots, the lines converging at the segmental divisions where they are bolder, and again before the second pair of dorsal tubercles. The entire skin surface is scattered with a profusion of tiny whitish or cream flecks and dots that break up the uniform ground colour which is darker above than ventrally. A pale dorsal stripe is present only on the thorax, with darker shading to each side of it that merges with the head banding. A fine crinkly lateral line of white or cream runs from the first abdominal segment on to the anal claspers.

The head appears ginger brown owing to dense short bands of freckling and it is streaked with two pale vertical bands like a clove. True legs pale reddish brown, prolegs tipped with pinkish, and anal claspers whitish and heavily streaked in front and behind with deep reddish brown.

Spiracles tiny rounded ovals, ringed with black and barely discernible from the tiny black tubercles which carry a single short soft hair. The spiracles rather larger on the prothorax and again on the sixth to eighth abdominal rings, all placed centrally but high above the lateral line.

The shape is of the rather thick *Cosymbia* type with little taper at either end and with the rounded head that is flattened in front.

In its earlier instars the larva of *C. puppillaria* rather resembles that of *C. pendularia* (Clk.), but at full growth it is in both forms so similar to the same stage of *C. porata* (F.) that I am quite unable to distinguish them; *C. puppillaria* is rather the larger. Amongst the large numbers of larvae we have reared there were very few that remained brown in the last instar.

Photographs by George Hyde

COSYMBIA PUPPILLARIA HUBNER

1, Eggs. 2, Larva.
3, Larva and pupa.
4, Female moth at rest.

Description of the pupa. Measures 12 mm. long by a little under 3.5 mm. at its broadest which is across the meta-thorax.

In shape it has the characteristic angular appearance of *Cosymbia*, the bulbous eye-cases, squared, flat-ended thorax and head, raised hind margins of the wing cases to terminate in a large pink tubercle, slightly flattened dorsally, and with even taper from the thorax.

Wing cases and ventral surface paler than the dorsum, even blanched, the wing cases darker streaked along the veins and whitish along the hind margin. The last abdominal segment is also pale but with a central dark streak dorsally. Cremaster a dark wrinkled and contorted structure placed on the dorsal aspect.

Spiracles narrow oval. Cuticle much flecked with pale particles on the darker dorsal surface. The fifth and sixth abdominal segments free, the cuticle of these rings and of the fourth has the posterior part quite smooth and free from the rugose pitting present throughout the dorsal aspect of all other segments except on their narrow posterior margins.

The few brown pupae that occurred in our broods were of uniform colouration, being a delicate pale pinkish colour dorsally and cream on the ventral surface. Amongst the green forms the commonest was of a bright emerald hue, but yellower and darker forms occurred, some of the loveliest being more blue or sea-green, while indigo and violet shades were present rarely.

A substantial pad of silk is spun at the cremaster with a further touch to each side of the wing cases, to which the strands of the girdle are attached. The pupa is frequently placed in a curved leaf when a few other strands of silk may be loosely spun across its surface.

The time spent in the pupal stage is commonly as short as 9-14 days, but amongst late summer and autumn insects the period extended to over three weeks. The day before emergence of the moth the wing markings can be clearly seen and also the dorsal blotches of the abdomen.

BOOK REVIEW

Proceedings and Transactions of the South London Entomological and Natural History Society for 1956. Pub. Oct., 1957. Pp. xliv, 177; nine plates. Wrappers. Price 18s.

Appearing in time for distribution at the Society's Annual Exhibition on the 26th of October, 1957, this Volume reflects credit on the editors both by its prompt publication and by the maintenance of its usual high standards. The accounts of ordinary and field meetings, and of the last Annual Exhibition, show that the Society's activities are also well maintained, and the increase in membership, albeit a small one, points in the same direction.

The President delivered as his Annual Address 'An Appreciation

of the Contribution made by Amateurs of the past to the Knowledge of the British Lepidoptera'. Of great historical interest, this Address gave biographical substance to many familiar names and well merited recognition to their bearers.

The Transactions comprise seven titles. Two of these papers are of particular interest to lepidopterists. Baron De Worms' account of 'The Wainscots' is an admirably succinct and informative summary of available knowledge of the British moths included in this category. More such papers are needed and, we hope, will be forthcoming. Any collector who visits the Burren of Clare without a copy of H. C. Huggins' 'A Naturalist in the Burren' may well find that he has also left his net at home, for either lapse would imply an equal degree of improvidence.

'The Zoogeography of the British Hemiptera', by T. R. E. Southwood, presents the reader with all, and more, of the information implied by its explicit title, and Claude F. Rivers' 'Advances in Insect Virus Research' is a paper of great interest illustrated by a series of excellent photographs. The three remaining papers are divided among three different orders of insects: 'De-Scaling in *Gonodontis bidentata* Clerck', by Stuart E. W. Carlier; 'Gall Wasps (Cynipidae Hym.) of the Compositae', by M. Niblett; and 'Notes on the Leaf-mining Diptera', by M. Niblett. M.W.F.T.

RECENT LITERATURE

A Survey of the Lepidoptera of a Small Oak-Beech Wood on the Midland Keuper Marl with ecological notes on the species and two Appendices. By H. E. Hammond, F.R.E.S. (Proc. Birmingham Nat. Hist. & Phil. Soc. Vol. 16, pt. 6. March, 1957. pp. 147-173). Price 6s. Available from the Society at The Midland Institute, Birmingham.

It is a pleasure to call attention to this excellent paper published, as it should be, in the Proceedings of the Natural History Society of the district in which the research is situated. This Survey, by an amateur naturalist of some eminence, is obviously the result of many years of painstaking study and observation. Fortunately his excellent field work is matched by the able manner in which he has presented it in print. The 'List of species' is in tabular form, and this greatly facilitates reference and clarity.

Of the two appendices mentioned in the title one is held over for publication later, but the first is a short list of Dipterous and Hymenopterous parasites.

In the same volume three other papers appear, two of them of some interest to entomologists—*Cadbury, Hœwkes and Readett:* Flora of Warwickshire—Species distribution Maps and Habitat Analyses. *Carlier, S.E.W.* Some Leguminous Plants and the Lepidopterous insects which feed on them (contd.). E.W.C.

RECORDS OF CECIDOMYIDAE (DIPT.)

By S. A. MANNING, F.L.S., F.R.E.S.

This paper records the results of collecting done at various places outside Norfolk during the years 1951-56. When a place-name is first mentioned it is followed by the name of the county in which it occurs.

The nomenclature of the gall midges is that of Kloet and Hincks (1945).

Lasioptera rubi Heeger. The characteristic galls were found on Bramble stems (*Rubus* sp.) at Ewhurst, Surrey, September, 1951; near Hertford, Hertfordshire, May, 1952; near St. Olave's swing bridge, E. Suffolk, 18.iv.1952; Kingham, Oxfordshire, September, 1955.

Rhabdophaga rosaria (H. Loew). 'Rosette' galls on *Salix ?alba*, near Hertford, May, 1952.

Dasyneura affinis (Kieffer). Galls of the European Violet leaf midge were found on Violet leaves (*Viola* sp.) at Ewhurst, 29.ix.1951 (containing the gregarious pale orange larvae); Coombes churchyard, near Shoreham-by-Sea, Sussex, 17.x.1952 (midges emerged indoors, 17th-20th October, 1952).

D. aparines (Kieffer). Terminal 'pineapple' galls containing gregarious pale sulphur-yellow larvae were found on *Galium aparine* L., Shoreham-by-Sea, 22.vi.1952.

D. crataegi (Winn.). The terminal rosettes were found on Hawthorn (*Crataegus*) at Ewhurst, September, 1951; near Hertford, May-July, 1952; bank of the Adur estuary, Shoreham-by-Sea, 9.vii.1952 (the gregarious orange larvae were present); Kingham, 23.ix.1955, July, 1956.

D. filicina (Kieffer). The gall rolls were present on *Pteridium aquilinum* (L.) Kuhn at Ewhurst, 4.x.1951.

D. fraxinea (Kieffer). The circular pustules on leaflets of *Fraxinus excelsior* L., were seen at Ewhurst, September, 1951; Kingham, July, 1956.

D. fraxini (Kieffer). Pouch-galls were present on the leaflets of *Fraxinus excelsior* L., at Ewhurst, September, 1951; Lancing, Sussex, 8.vi.1952; near Hertford, May, 1952; Kingham, 23.ix.1955, July, 1956.

D. plicatrix (H. Loew). Galls with gregarious white larvae were on Bramble leaves (*Rubus*) at Ewhurst, September, 1951; Shoreham-by-Sea, 22.vi.1952; Lancing, 20.ix.1952; Kingham, 27.vi.1956.

D. pustulans (Ruebs.). Gall-pustules were present on leaves of *Filipendula ulmaria* (L.) Maxim., at Hertingfordbury, near Hertford, June, 1952.

D. tiliamvolvens (Ruebs.). The marginal rolls on Lime leaves (*Tilia*) contained gregarious orange-red larvae at Haileybury, near Hertford, June, 1952.

D. trifolii (F. Loew). Galls were on Clover plants (*Trifolium*) at Ewhurst, September, 1951; Lancing, 20.ix.1952; Kingham, 2.vii.1956 (pupae present).

D. ulmariae (Bremi-Wolf). Galls were seen on leaves of *Filipendula ulmaria* (L.) Maxim., at Hertingfordbury and Haileybury, both near Hertford, June, 1952; Kingham, July, 1956.

D. urticae (Perris). Galls on *Urtica dioica* L., at Ewhurst, 3.x.1951; Hertingfordbury, near Hertford, June, 1952.

Taxomyia taxi (Inchbald). 'Artichoke' galls on *Taxus baccata* L., at Ewhurst, September, 1951; Kingham, 23.ix.1955; near Rainham, Kent, 22.ii.1953 (collected by Mr. A. P. Major).

Jaapiella veronicae (Vallot). Galls were seen on *Veronica chamaedrys* L., at Ewhurst, September, 1951; Lancing, 14.vi.1953 and 20.ix.1952; Hertingfordbury and Haileybury, near Hertford, May and June, 1952; Kingham, 23.ix.1955, and with cocoons (pupae) on 2.vii.1956.

Cystiphora sonchi (F. Loew). Gall-pustules were present on leaves of *Sonchus arvensis* L., at Lancing, 20.ix.1952 (containing orange larvae); Kingham, July, 1956.

Wachtliella stachydis (Bremi-Wolf). Leaf rolls and terminal gall-masses containing pale yellow-orange gregarious larvae were present on *Stachys sylvatica* L., at Lancing, 8.vi. and 20.ix.1952.

Hartigiola annulipes (Hartig.). Galls on leaves of *Fagus sylvatica* L., Ewhurst, September, 1951.

Rondaniola bursaria (Bremi-Wolf). 'Lighthouse' galls were on leaves of *Glechoma hederacea* L., at Ewhurst, September, 1951; Lancing, 8.vi.1952; Kingham, 23.ix.1955.

Contarinia corylina (F. Loew). White larvae present in swollen and deformed catkins of *Corylus avellana* L., at Ewhurst, 4.x.1951.

C. tiliarum (Kieffer). The globular galls containing pale sulphur-yellow larvae were collected from Lime trees (*Tilia*) at Lancing and Shoreham-by-Sea, 14.vi.1953; near Hertford, May, 1952.

C. betulina (Kieffer) (= *Anisostephus betulinum* (Kieffer)). There were roundish pustules on Birch leaves (*Betula*) at Ewhurst, September, 1951, but no larvae were seen.

Macrodiplosis volvens Kieffer. Marginal rolls present on leaves of *Quercus petraea* (Matt.), Ewhurst, 18.x.1951.

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